MMM

MODEL 8155A
AUDIO FLUTTER METER

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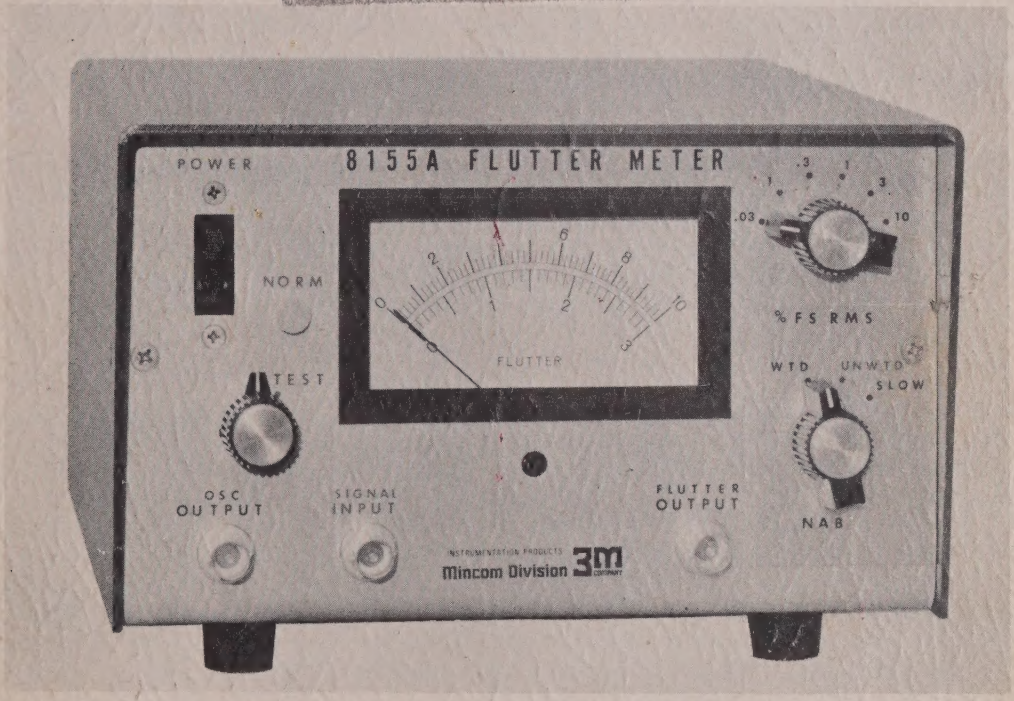

OPERATION AND
MAINTENANCE MANUAL

INSTRUMENTATION PRODUCTS
Mincom Division 3M COMPANY

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MINCOM DIVISION OF 3M COMPANY certifies that this instrument was thoroughly tested and found to meet its published specifications when shipped from the factory. Mincom also certifies that its calibration measurements are traceable to the U. S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

SERIAL NUMBER 00051

☐ IEEE/DIN STANDARDS

☒ NAB STANDARDS

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MODEL 8155A
AUDIO FLUTTER METER

CATALOG NO. 83-5990-1312

INSTRUMENTATION PRODUCTS
Mincom Division 3M COMPANY

JANUARY 1972

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NOTE: Please contact the above for shipping instructions before returning equipment for repair and/or calibration.

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SECTION I
GENERAL DESCRIPTION

GENERAL

The Model 8155A Audio Flutter Meter is manufactured by the Mincom Division of the 3M Company at Camarillo, California. It is a compact, general purpose, solid state test instrument for measuring weighted or unweighted flutter over a frequency range of 0.5 to 200 Hz. The instrument is easily portable and features accuracy, reliability, and operator convenience. The source power is switch selectable. It can be either 115 volts, 48 to 500 Hz or 230 volts, 48 to 500 Hz.

Two configurations are available. One is used for flutter measurement in accordance with IEEE standards (also suitable for DIN standard measurement) and the second for measurement in accordance with NAB standards. A test signal source, compatible with the instrument configuration, is provided at the instrument front panel.

Instrument accuracy is ±5% at the full scale meter indication for any of the six sensitivity ranges (10%, 3%, 1%, .3%, .1%, or .03%). The meter reads peak flutter on the IEEE configured instruments and RMS flutter on NAB configurations. Exclusive use of solid state circuitry and extensive design testing insure reliability and long periods of maintenance free operation. A self-test feature has been incorporated to permit a check for normal operation and calibration at any time.

The flutter meter automatically accepts any input level within the specified range (100 MV to 150 volts rms). An illuminated NORM indicator on the instrument front panel indicates an acceptable input signal is present. Instrument bandpass (weighted or unweighted) is switch selected. In the IEEE configuration the meter is automatically damped when using the unweighted bandpass (for reading ease). The NAB version has a third switch position, SLOW, where the unweighted bandpass is combined with a heavily damped meter.

INSTRUMENT SPECIFICATIONS

Table 1-1 gives detailed specifications applicable to the Model 8155A Audio Flutter Meter.

Table 1-1. Specifications

NOTE

Two basic versions, IEEE and NAB, are available.

Test Signal Input

Frequency: 3150 Hz IEEE/DIN, 3,000 Hz NAB.
Input Level: 100 MV to 150V RMS.
Input Impedance: 300K ohms, unbalanced.
Input Noise Susceptibility: 15 dB signal + noise to noise ratio to maintain basic accuracy.
Tolerability to Dropouts: At least 20 dB for dropouts of <20 ms duration at an input level of 100 MV RMS or higher.

Table 1-1. Specifications (Cont.)

Signal Failure Clamp

Restores meter to "zero" when signal is below level for proper operation. Dropouts of <20 ms at an input level of 100 MV or higher are ignored.
"Normal" Level Indicator: Lights to indicate the input level is within operating range.

Flutter Measurements

Test Ranges: 10%, 3%, 1%, .3%, .1%, and .03%, + or – peak full scale, IEEE/DIN or % RMS full scale NAB.
Bandwidth, (Standard, IEEE or Weighted - NAB): Within specification limits for IEEE/DIN, and NAB standards for weighted response.
Meter Damping: Conforms to IEEE and DIN standards for pulse response in the IEEE version. In the NAB version the meter is damped to the VU characteristic.
Accuracy: ±5% at full scale with an input frequency of 3150 Hz (IEEE) or 3000 Hz (NAB) modulated with a 4 Hz sine wave, see curve for typical response.
Bandwidth, Unweighted: See curve for typical response.
Accuracy: ±5% at full scale with an input frequency of 3150 Hz (IEEE) or 3000 Hz (NAB) modulated with a 40 Hz sine wave. Meter highly damped for ease of reading in IEEE "Unweighted" and NAB "Slow". Meter has VU response for NAB "Unweighted" measurements.

Flutter Demodulator Output

Output Level: 100 MV RMS at full scale flutter meter indication.
Source Impedance: 1K ohm, unbalanced.
Response: Same as selected functions.
Accuracy: Same as flutter measurement specification.

Internal Test Oscillator

Frequency: 3150 Hz IEEE and 3000 Hz NAB (±0.2%).
Output Level: 1V RMS.
Source Impedance: 100 ohms, unbalanced.

Equivalent Internal Instrument Noise

≤0.002%, with a pure 3150 Hz (IEEE) or 3000 Hz (NAB) sine wave input, at 1V RMS, in "Standard" (IEEE) or "Weighted" (NAB) position.

Self Test

Self check causes meter to indicate 1% flutter in unweighted mode.

General

Connectors: BNC type.
Power: 115/230 VAC, 48 - 500 Hz, 5 VA.
Power Cable: Three wire, grounded.
Size: 8.25"W x 10"D x 5"H, 210mm x 254mm x 127mm.
Ambient Temperature Range: Operational 0° to +50°C, non-operational -28° to +65°C.
Humidity: Up to 95% without condensation.
Weight: 10 lbs, 4.55 Kg.
Finish: Per best commercial practice, colors per FED-STD-595.

SECTION II
INSTALLATION

RECEIPT INSPECTION

The Model 8155A Audio Flutter Meter is inspected, operationally checked, and calibrated prior to leaving the factory. A visual inspection for shipping damage should be made, and if inspection reveals any damage, the carrier should be notified immediately.

LOCATION CONSIDERATIONS

The Model 8155A Audio Flutter Meter may be used in almost any location where a suitable power source is available, so long as reasonable judgement is used. Visual and physical access to the front panel of the instrument is required.

SIGNAL CONNECTION

Interconnecting cables are not provided with the instrument. Type RG58A/U coaxial cable (or equivalent) is recommended. The flutter meter requires BNC connector interface.

POWER CONNECTION

CAUTION

The flutter meter is designed to operate on 115 or 230 volts ac power, however, a 115/230 voltage selector switch located on the rear panel of the instrument MUST be in the position which corresponds to the power source to be used. SEVERE DAMAGE WILL RESULT IF THE INSTRUMENT IS PLUGGED INTO A 230 VOLT SOURCE WHEN THE POWER SWITCH IS IN THE 115 VOLT POSITION.

The Model 3155A Audio Flutter Meter is equipped with a built-in three wire power cord with a grounding type plug. Power connection consists of: A) Placing the recessed 115/230 voltage selector switch, located on the rear panel of the instrument in the position which corresponds to the power source to be used, and B) Inserting the power plug into a mating receptacle (do not defeat the grounding provision through use of an ungrounded adapter).

SECTION III
OPERATION

GENERAL

Do not attempt to operate the Model 8155A Audio Flutter Meter before confirming that the POWER CONNECTION procedure outlined in Section II has been properly completed.

The instrument has been operationally tested and properly calibrated prior to leaving the factory. Normal operation can be anticipated, without further setup or adjustment, after a nominal warmup time of 10 to 15 seconds.

Most flutter measurements are normally made using commercially available test recordings. If an appropriate recording is not available, one must be made. A suitable reference signal for this type of recording is provided at the OSC OUTPUT connector on the front panel of the flutter meter. The test signal is present whenever power is applied to the instrument. The oscillator output should be recorded to provide the best possible signal-to-noise ratio. When making a test recording, it is important to remember that flutter is introduced during the recording process. If the percentage of flutter introduced during the recording process is unknown, it is generally assumed the correct flutter reading will be between 0.5 and 0.7 percent of that indicated on the flutter meter.

CONTROLS AND INDICATORS

All operating controls and indicators, as well as signal input and output connectors, are located on the front panel of the instrument. (The 115/230 volt switch on the rear panel is not classified as an operating control.) Table 3-1 lists each control, indicator, and signal connector and gives a brief functional description; figure 3-1 identifies and locates them.

Table 3-1. Controls, Indicators, and Signal Connectors

TITLE	FUNCTIONAL DESCRIPTION
	CONTROLS
POWER Switch	Controls application of line power. Translucent switch body is backlighted when switch is in the on position.
TEST Switch	Spring loaded switch which enables self-test capability.
% PEAK (IEEE) or %FS RMS (NAB)	Instrument sensitivity switch. Six sensitivity ranges (10%, 3%, 1%, .3%, .1%, and .03%). Switch position identifier indicates percent value of full scale meter reading.
IEEE or NAB Switch	Instrument function selector switch. IEEE switch has two positions: STD (bandpass is weighted in accordance with IEEE/DIN standards), and UNWTD (bandpass is not weighted). The NAB switch has three positions: WTD (bandpass is weighted in accordance to NAB standards), UNWTD (bandpass is not weighted), and SLOW (unweighted bandpass with heavily damped meter).

Table 3-1. Controls, Indicators, and Signal Connectors (Cont.)

TITLE	FUNCTIONAL DESCRIPTION
INDICATORS	
POWER Indicator	POWER switch is illuminated when power is on.
NORM Indicator	Lights when input signal is within acceptable limits.
Flutter Meter	Gives visual indication of percent flutter present in input signal. Readout is % PEAK indication on IEEE instruments and % RMS on NAB instruments.
SIGNAL CONNECTORS	
OSC OUTPUT	BNC type connector. Test signal from flutter meter (3.15 kHz for IEEE instruments; 3.0 kHz for NAB instruments).
FLUTTER OUTPUT	BNC type connector. Flutter component present in input signal. For monitoring purposes.
SIGNAL INPUT	BNC type connector. Input point for signal from equipment being evaluated for flutter performance.

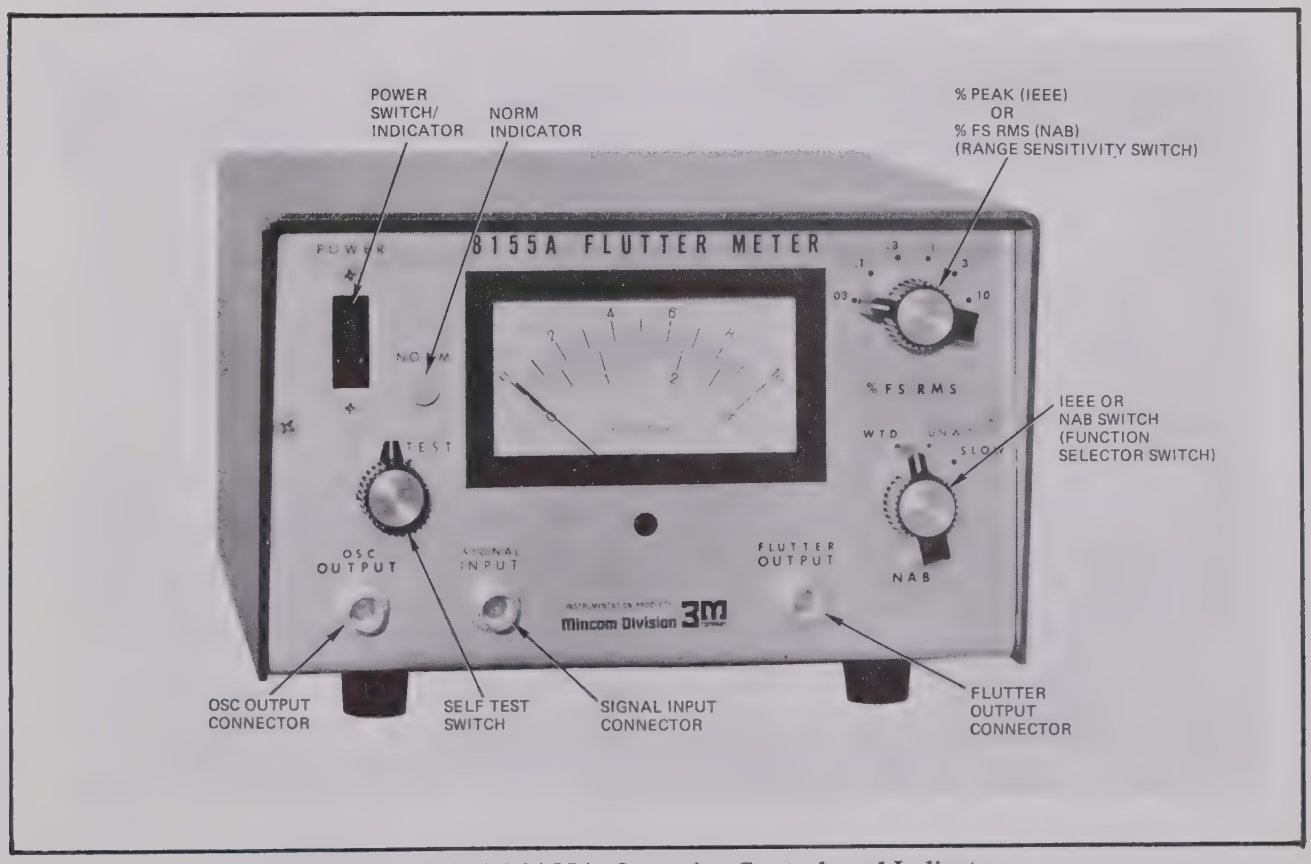


Figure 3-1. Model 8155A, Operating Controls and Indicators

NOTE

It is not the intent of this manual to fully describe the exact test methods, procedures, etc., described in applicable industry standards. The IEEE/DIN and NAB MEASUREMENT DATA paragraphs are simplified excerpts intended to assist in understanding instrument operation. The user should always refer to the latest issue of the applicable standard for precise and current information.

IEEE/DIN MEASUREMENT DATA

The IEEE/DIN standards indicate that weighted peak flutter shall be measured using a test frequency of 3150 Hz. The measurements shall be made on one element only of the system (either the recorder or the reproducer, but not on both) under such conditions that the weighted peak flutter in the remaining parts of the measuring system is negligible.

NOTE

When this condition cannot be fulfilled, a recorder/reproducer may be measured by recording a 3150 Hz test frequency and subsequently reproducing this record several times, measuring in each case, the total weighted peak flutter and calculating the arithmetic average value of these measurements. The weighted peak flutter of delay devices (whose normal operation employs simultaneous recording and reproducing) shall be measured while simultaneously recording and reproducing.

In most sound recording equipment, the weighted peak flutter will vary with system conditions. The weighted peak flutter should, therefore, be measured and reported for each of the various pertinent conditions. A single value of weighted peak flutter reported for a system whose weighted peak flutter varies with system conditions shall be for the worst combination of factors.

Weighted peak flutter measured shall be reported in the following manner:

"Weighted peak flutter of the recorder: ± ___%", or
"Weighted peak flutter of the reproducer: ± ___%", or
"Weighted peak flutter of the recording/reproducing system: ± ___%".

NAB MEASUREMENT DATA

The NAB standards for reel-to-reel and cartridge tape recorders require flutter to be measured while reproducing an essentially flutter-free recording of 3 kHz. Measurements shall be made at the beginning, middle, and end of the tape reel or cartridge. The highest reading of the three positions measured shall be reported, excluding random peaks which do not occur more than three times in any 10-second measurement period. For reel-to-reel recorders, weighted and unweighted flutter shall be measured; for cartridge recorders, only unweighted flutter shall be measured. Table 3-2 lists the NAB flutter limits for various tape speeds.

Table 3-2. NAB Flutter Standards

TAPE SPEED (ips)	REEL-TO-REEL		CARTRIDGE
	UNWEIGHTED FLUTTER (% rms)	WEIGHTED FLUTTER (% rms)	UNWEIGHTED FLUTTER (% rms)
15	0.15	0.05	———
7.5	0.20	0.07	0.2
3.75	0.25	0.10	———

OPERATING INSTRUCTIONS

The instructions which follow describe the procedures for instrument self-check, IEEE/DIN flutter measurement, and NAB flutter measurement. The procedures presented are for tape recorders, but are fully applicable to other types of equipment (i.e., film drives and turntables).

NOTE

Approximately 30 seconds should be allowed after application of an input signal to permit the meter to settle.

SELF-CHECK PROCEDURE

This procedure checks operation and calibration of the flutter meter. Perform the self-check test before using the instrument for flutter measurements.

1. Set the POWER switch to on (switch body backlighted).

2. Set the %PEAK or %FS RMS switch (whichever is applicable) to the 1% position (color coded blue) and the IEEE or NAB switch to UNWTD position (also color coded blue).

3. Rotate the spring loaded test switch clockwise to TEST position and hold. The flutter meter should indicate full scale ±2% (±1 division on the 1 to 10 scale). The NORM indicator should be illuminated.

IEEE/DIN FLUTTER MEASUREMENT PROCEDURES

The IEEE/DIN flutter measurement procedure using pre-recorded test signals are as follows:

1. Connect the source of the signal to be evaluated for flutter content to the SIGNAL INPUT connector of the flutter meter.

2. Set the % PEAK switch appropriately and the IEEE(function) switch to STD.

3. Measure the weighted peak flutter for each significant operating condition and record the data as indicated in the IEEE/DIN MEASUREMENT DATA paragraph.

The IEEE/DIN flutter measurement procedure when a pre-recorded test signal is not available is as follows:

1. Connect the record input of the recorder/reproducer to the OSC OUTPUT connector of the flutter meter.

2. Connect the reproduce output of the recorder/reproducer to the SIGNAL INPUT connector of the flutter meter.

3. Record the test signal produced by the flutter meter oscillator. (This signal is present at the OSC OUTPUT jack whenever power is applied to the flutter meter.)

NOTE

Use only high-quality tape, BULK-ERASED before use.

4. Rewind the tape. Set the %PEAK switch appropriately and the IEEE switch to STD.

5. Reproduce the recording several times recording the resultant flutter reading each time. (Read peak meter excursions.) Average the individual readings to obtain a representative reading.

NAB FLUTTER MEASUREMENT PROCEDURE

The NAB flutter measurement procedure is as follows:

1. Load the recorder with a test tape:

   a. For reel-to-reel recorders, use an essentially flutter-free 3 kHz test tape (if available); or use high-quality bulk-erased tape and record the 3 kHz output of the flutter meter (OSC OUTPUT) connector to the recorder's record input) over the full length of the tape.

   b. For cartridge recorder, use NAB Test Tape No. 2 Flutter.

2. Connect the reproduce output of the recorder to the SIGNAL INPUT connector of the flutter meter.

3. Set the %FS RMS switch and the NAB switch as required for the measurement being made.

4. Measure weighted and unweighted flutter at the beginning, middle, and end-of-reel, switching the NAB and %FS RMS switch positions as appropriate for the measurement being made. (Read peak meter excursions.) Table 3-2 lists the acceptable flutter limits according to NAB standards.

SECTION IV
FUNCTIONAL DESCRIPTION

GENERAL

The flutter meter circuitry can be divided into seven functional areas. The areas are: power supply, internal test oscillator, input signal conditioning, demodulator, low pass filter, weighting filter, and meter amplifiers. Figure 4-1 is a functional block diagram of the flutter meter.

POWER SUPPLY. The power supply (see figure 4-2) consists of two similar rectification and regulator sections. One section provides +25 volts dc unregulated and +15 volts dc regulated; the second provides −25 volts dc unregulated and −15 volts regulated. The twin primarys of the power transformer are cross-connected through a line power selector switch to permit operation from either 115 or 230 volts ac. Full wave rectification is employed and the basic regulator is of the series pass design. The regulator reference voltage is developed across a zener diode and connected to one input of an IC operational amplifier. The output of the amplifier is connected to the series pass element. A portion of the output voltage from the pass element is fed back to the second input on the operational amplifier. This input voltage is compared against the reference voltage, and the resulting error voltage is amplified and fed back to the pass element.

INTERNAL TEST OSCILLATOR. The internal test oscillator (see figure 4-3) is an RC triangle oscillator. It consists of three interconnected integrated circuits: an integrator (IC3), a voltage comparator (IC4), and an active low pass filter (IC5).

Oscillator frequency is determined by C9, R14 and the peak-to-peak level of the signal at the junction of R12, 13, 14, and 15. R16 provides adjustment of the junction level and is used to adjust frequency. The triangle output from IC3 is coupled to active low pass filter IC5. The purpose of the filter is to remove the harmonics from the triangle oscillator and leave a clean sine wave for test and recording purposes. Potentiometer R20 at the input to IC5 is used to adjust the OSC OUTPUT level to 1 volt rms. Transistor Q3 and potentiometer R11 are used to generate the "Self Test" signal. In the "Self Test" mode, a 60 Hz signal from the power supply is connected to the gate of Q3. This causes it to turn off and on, at a 60 Hz rate. Each time Q3 is on, the oscillator frequency is lowered. The amount it is lowered is dependent on the setting of R11. R11 is used to calibrate the "Self Test" mode.

INPUT SIGNAL CONDITIONING CIRCUITS. The input signal conditioning circuitry (see figure 4-4) consists of an input amplifier, signal level detector, limiter/amplifier, and frequency doubler. The input signal is coupled to the input of amplifier IC6 through a peak-to-peak limiting circuit which includes a low pass filter. The low pass filter (R24, 25, C12, and C13) reduces the influence of undesired input signals. Signal limiting is accomplished by front to back diodes CR5 and CR6 in conjunction with R24. The only practical limit on input signal amplitude is the voltage rating of R24 (nominal limit is specified at 150 volts rms).

IC6 and its associated components form the input amplifier. The feedback components establish a gain of approximately 120 at small input signal levels. When the amplifier output level becomes large enough to cause CR7 and CR8 to conduct, the gain is reduced to approximately 20. The output of IC6 is coupled to level detector IC7 and limiter/amplifier IC8.

Input signal level detector IC7 accepts the output signal from IC6 and half wave rectifies it (CR10 and C16) for comparison to a dc bias level. When the average dc level across C16 is higher than the bias applied to pin 2 of IC7, the output level of IC7 will change from −0.6 volts dc to +13 volts dc. Resistor R35 provides a small amount of positive feedback to eliminate intermittent operation with noisy signals at threshold level. The +13 volts is applied to the base of Q6 which conducts heavily, causing the NORM indicator to light and the signal clamp bias voltage to drop to approximately zero volts.

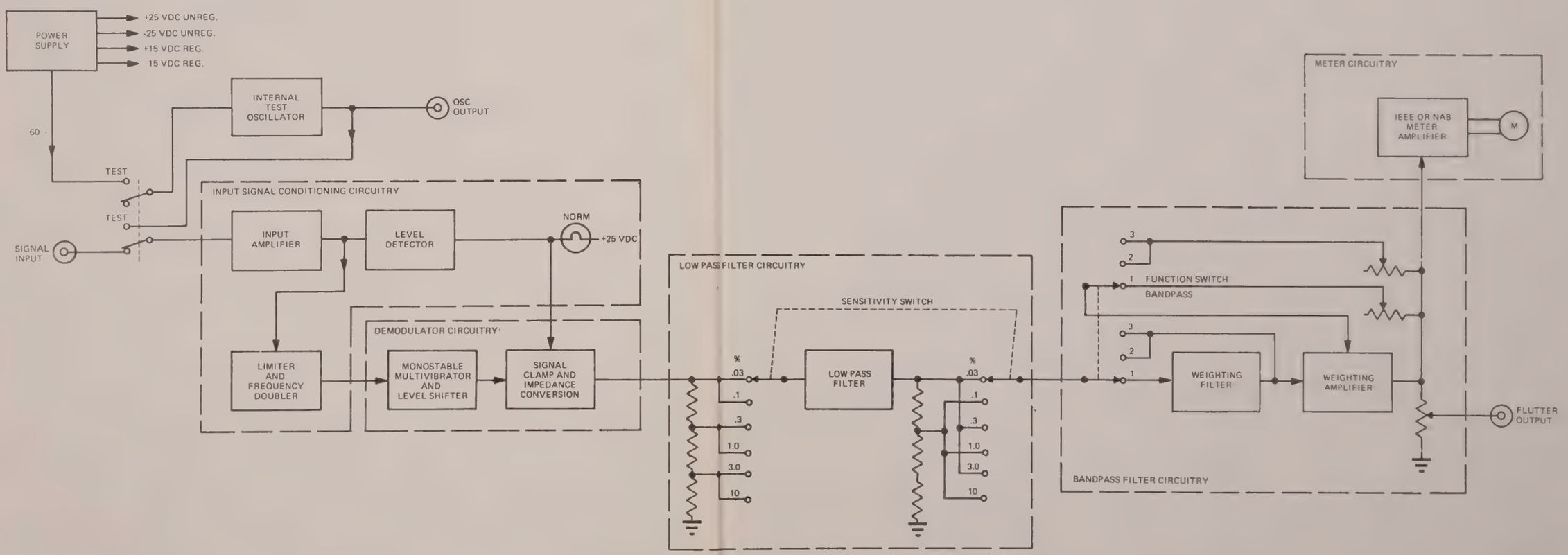


Figure 4-1. Functional Block Diagram

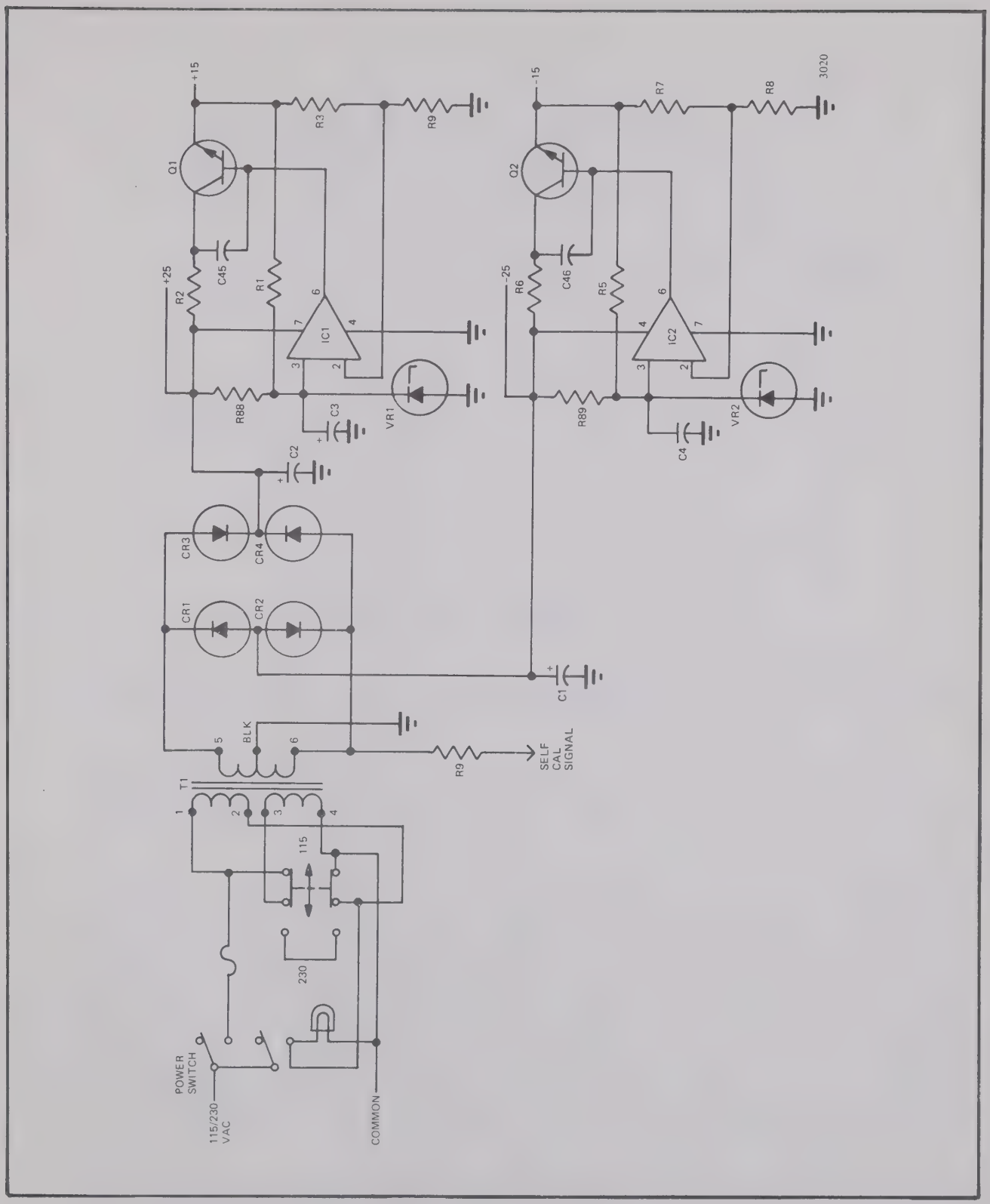


Figure 4-2. Power Supply

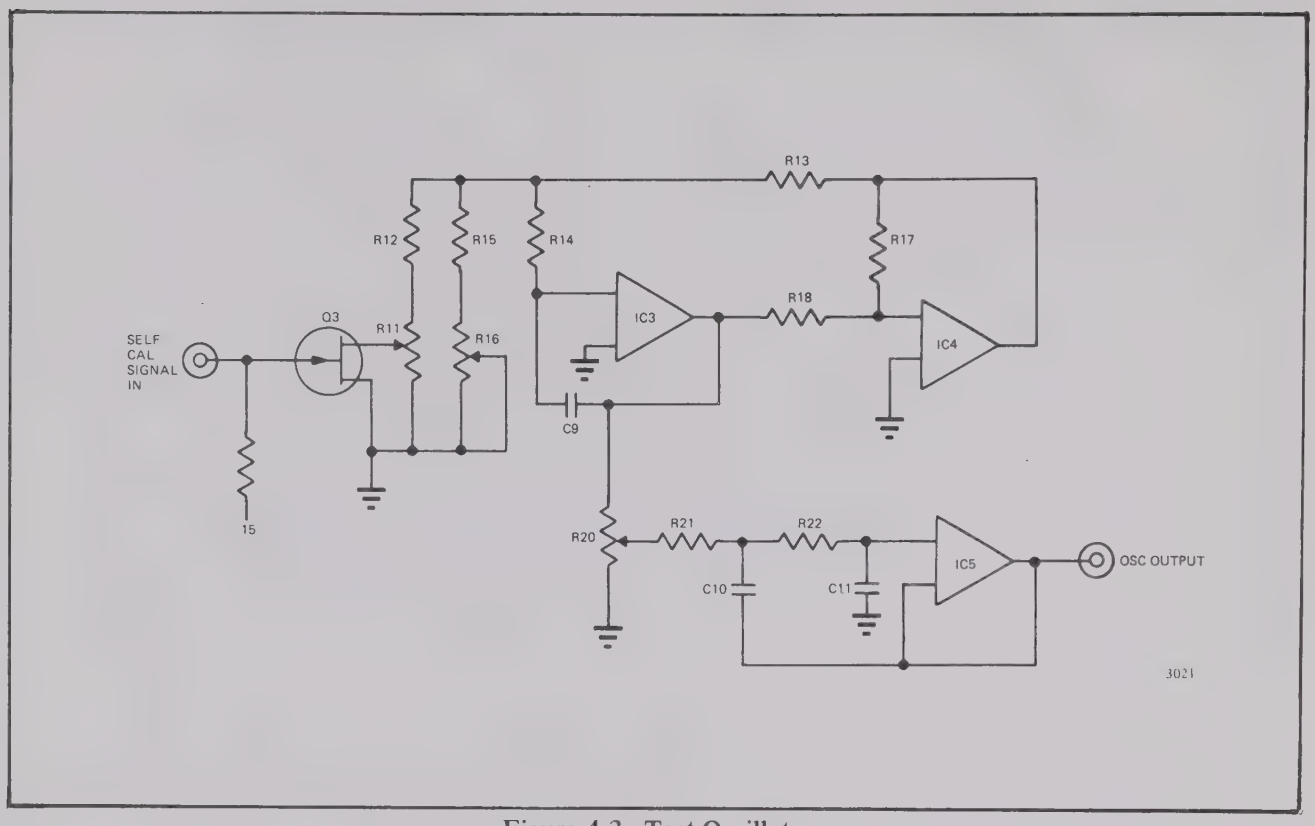


Figure 4-3. Test Oscillator

Limiter/amplifier IC8 accepts the IC6 output and amplifies and limits it to achieve a constant amplitude and rise time output for various input levels. The rise time is improved by the use of positive feedback. The feedback also prevents false triggering on system noise in the absence of an input signal.

The output of the limiter is connected to frequency doubling transistors, Q4 and Q5. When the limiter output makes a negative transition, Q5 is momentarily turned off. This action causes a positive pulse to be generated at the collector of Q5. When the output of IC8 makes a positive transition, Q4 conducts momentarily. This cuts off the Q5 bias and generates a pulse as before. The result is a Q5 output of two pulses per cycle of input.

DEMODULATOR CIRCUITRY. The demodulator circuitry (see figure 4-5) consists of monostable multivibrator IC9 and amplifier IC10. Flutter demodulation is accomplished by the pulse count demodulator technique. Monostable multivibrator IC9 accepts the pulses from the frequency doubler and converts them to constant width and amplitude pulses. These pulses are applied to the base of Q9 which serves as a level shifter to provide an average output of zero volts dc in the presence of a flutter free input reference signal. Resistor R95 adjusts the pulse width from IC9 to insure the zero volt output. IC10 provides impedance conversion and some low pass filtering. The zero (input) signal clamp bias voltage from the level detector is applied to IC10 via transistors Q7 and Q8. When no input signal is present, the signal clamp voltage from the level detector is high, therefore, the bias on Q7 and Q8 is high causing both transistors to conduct heavily. Q7 swamps the signal from the level shifter and Q8 reduces the gain of IC10 to much less than one insuring no output signal will be present.

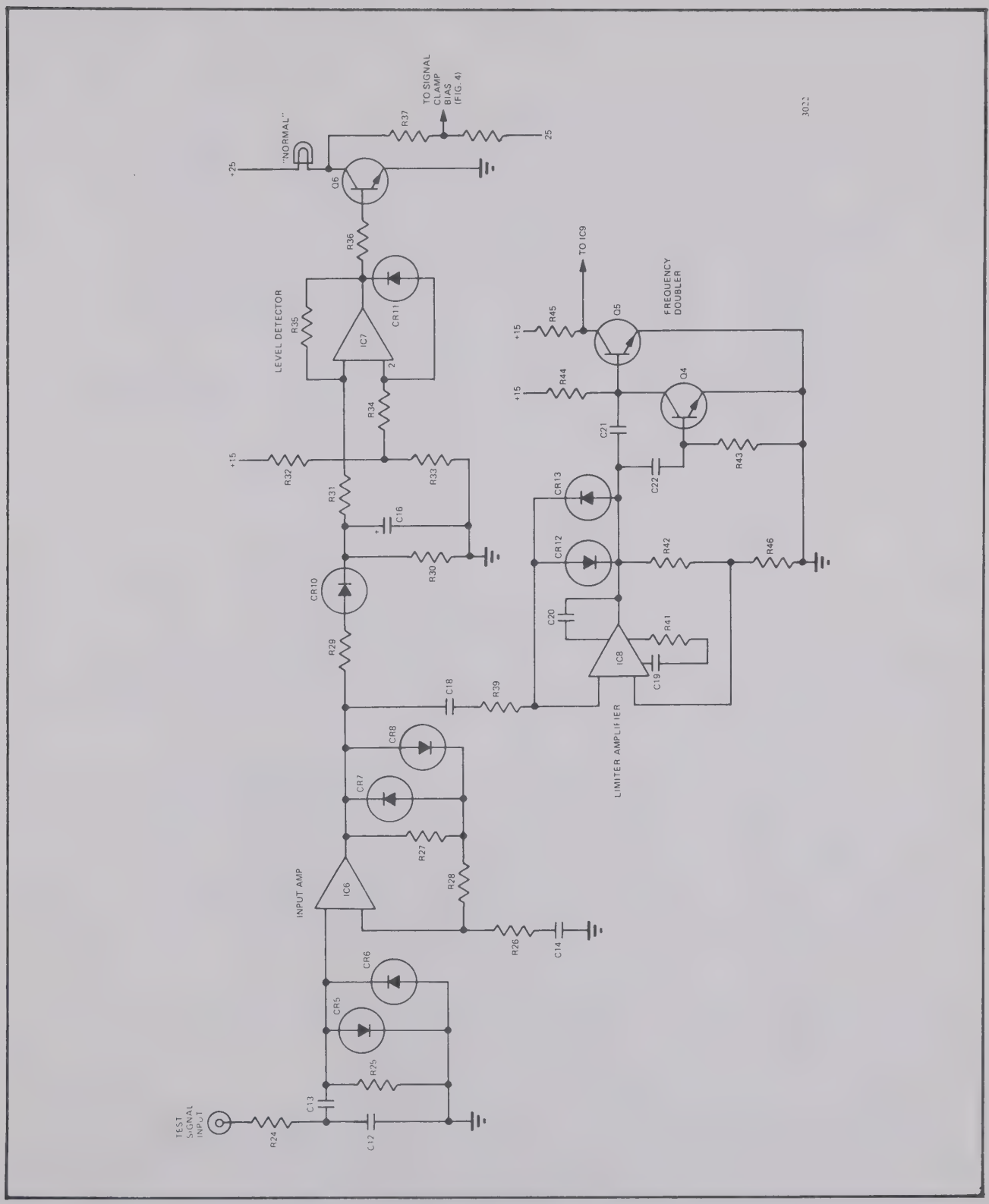


Figure 4-4. Input Signal Conditioning

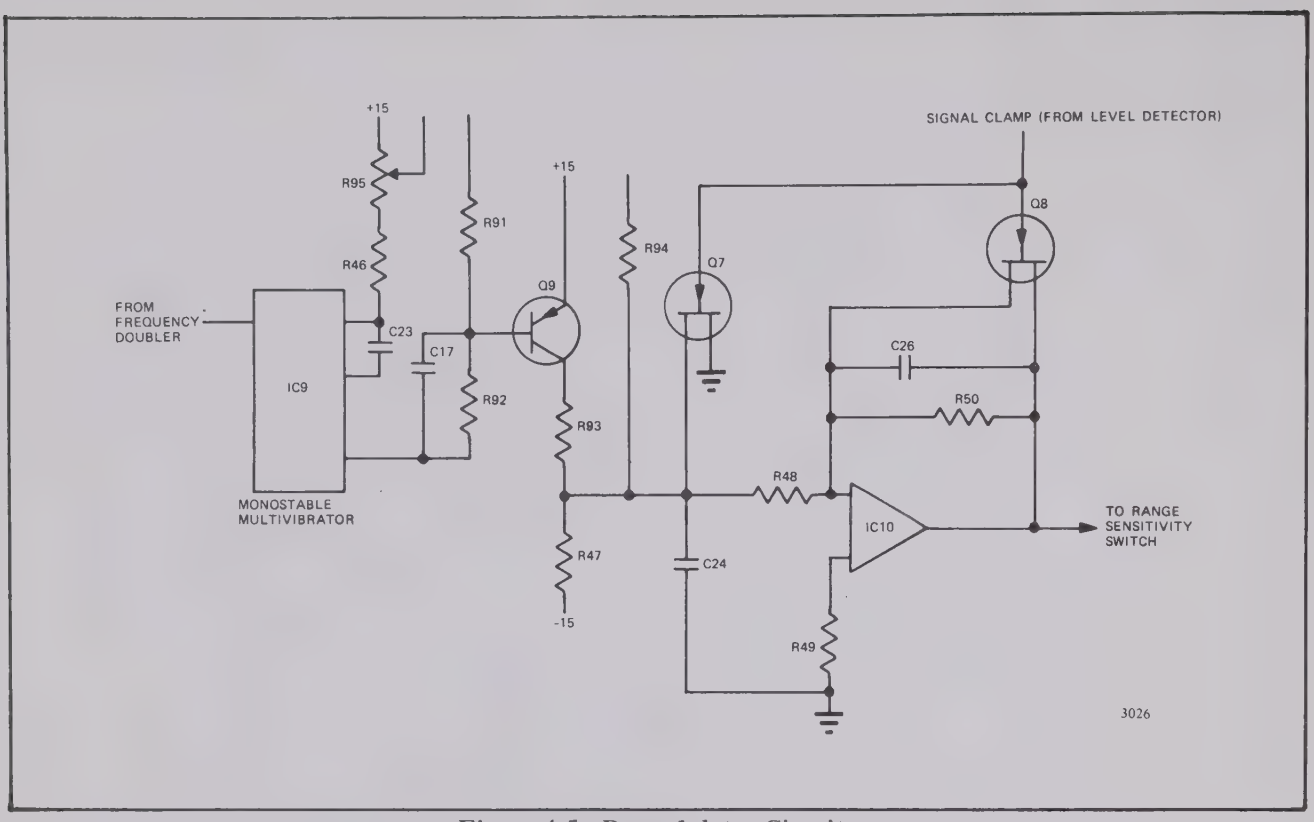


Figure 4-5. Demodulator Circuits

LOW PASS FILTER. IC11 and its associated components (see figure 4-6) form an active, 3 pole, Butterworth low pass filter. The purpose of the filter is to remove the carrier (reference frequency) from the flutter signal and to limit the instrument response to 200 Hz. The range sensitivity switch is operated in conjunction with this filter.

WEIGHTING FILTER. IC12 and its associated circuitry (see figure 4-7) form the weighting filter and amplifier. The input to IC12 is routed through the function (bandpass) switch. When the switch is in the weighted position (STD or WTD), the signal is passed through a two section RC high pass, and a single section low pass. This network sets the response for the "Weighted" characteristic. In the unweighted position, this network is bypassed and a flat response is provided. Figures 4-8 and 4-9 show typical response curves for the instrument. Potentiometers R69 and R70 provide the gain adjustments necessary to calibrate the flutter meter. The output from IC10 is routed to the meter amplifier and to potentiometer R71. The wiper arm of R71 is connected to the FLUTTER OUTPUT connector to provide a flutter monitor point.

METER AMPLIFIER CIRCUITRY. Figure 4-10 shows two meter amplifier circuits; one for IEEE/DIN instruments and one for NAB instruments. Only one is applicable to any given instrument (check instrument configuration noted on title page of this manual).

IEEE/DIN Meter Amplifier Circuitry. IC13, IC14 and their associated components form the peak-to-peak meter amplifier. IC13 is a negative rectifier and drives the positive side of the meter. IC14 is a positive rectifier and drives the negative side of the meter. The pulse response of the meter is shaped by the resistors and capacitors in series with and parallel to the meter. In the unweighted mode, capacitors C39 and C42 are switched in (through the function switch) to provide better low frequency response and damping. The two capacitors shown in dotted lines (C51 and C52) are the only selected components used in the unit. They are used, as required, to balance the meter circuit response to positive and negative peaks.

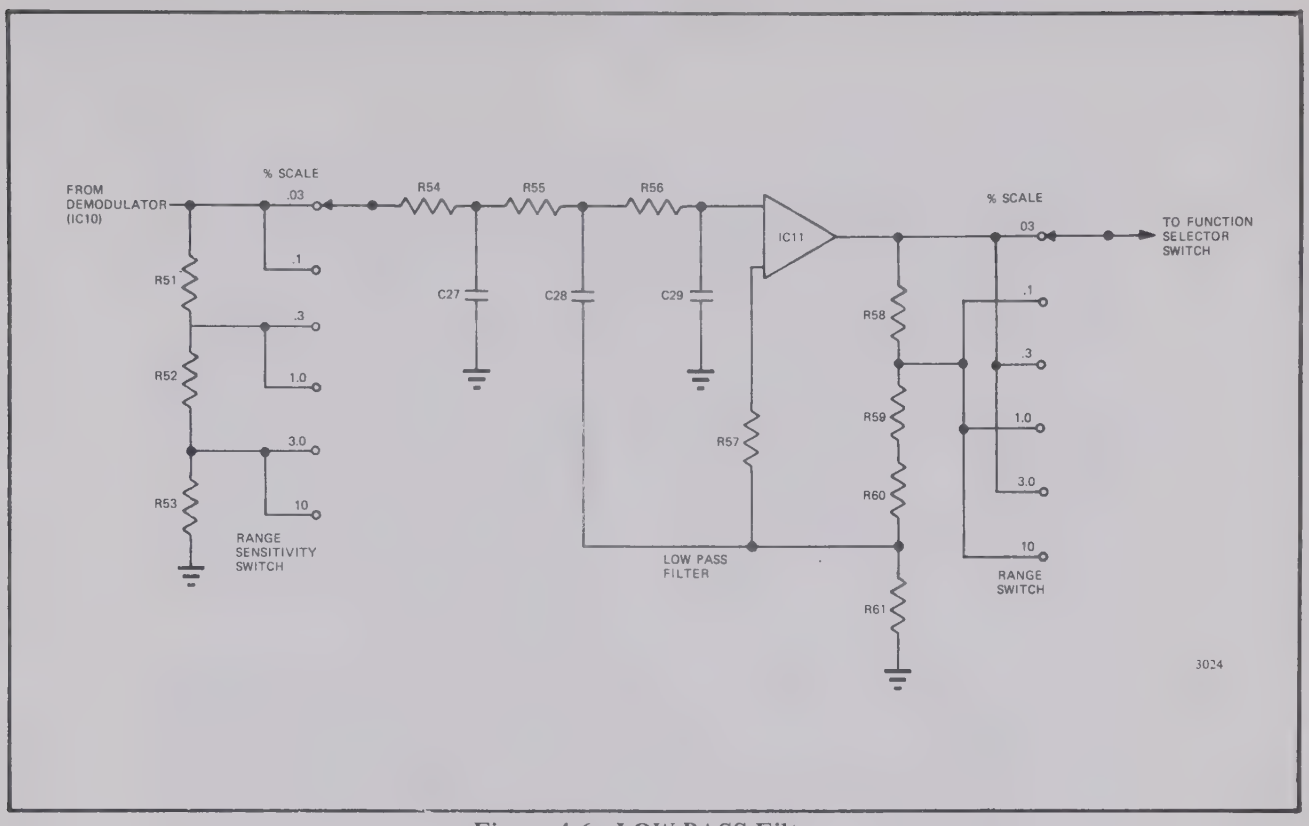


Figure 4-6. LOW PASS Filter

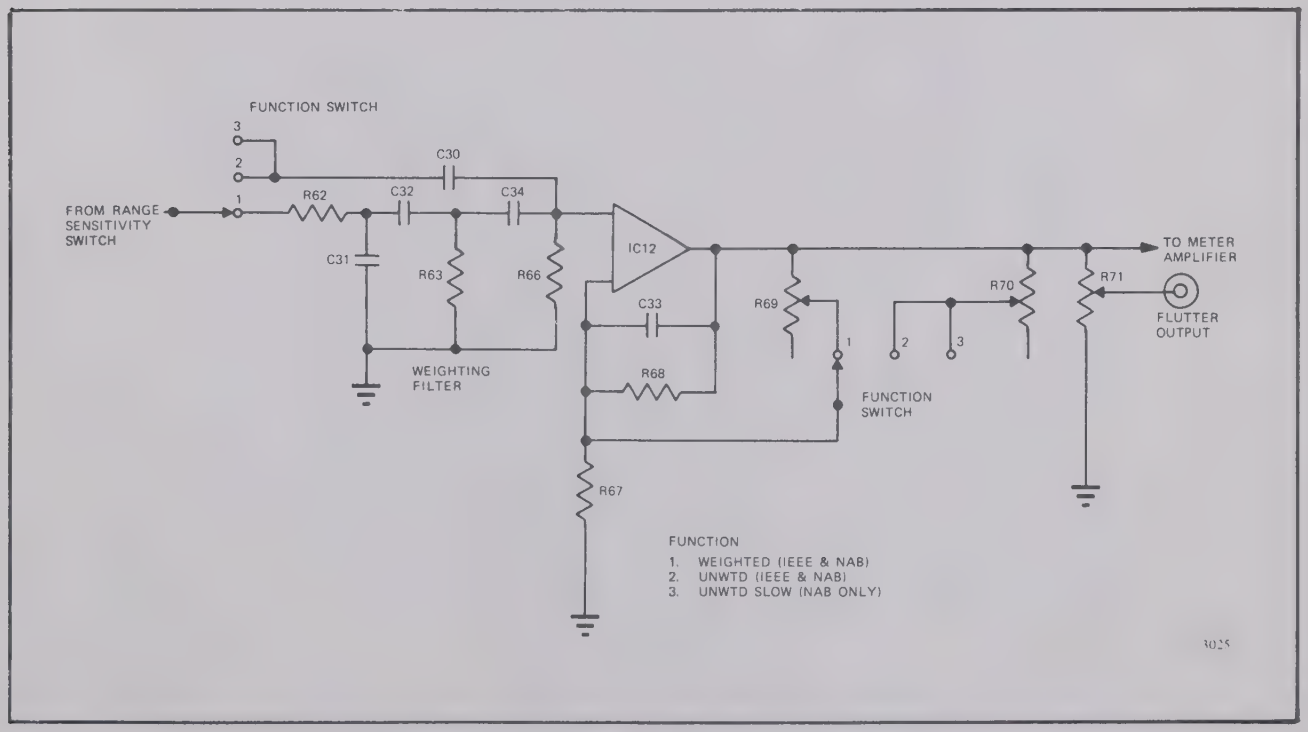


Figure 4-7. Weighting Filter and Amplifier

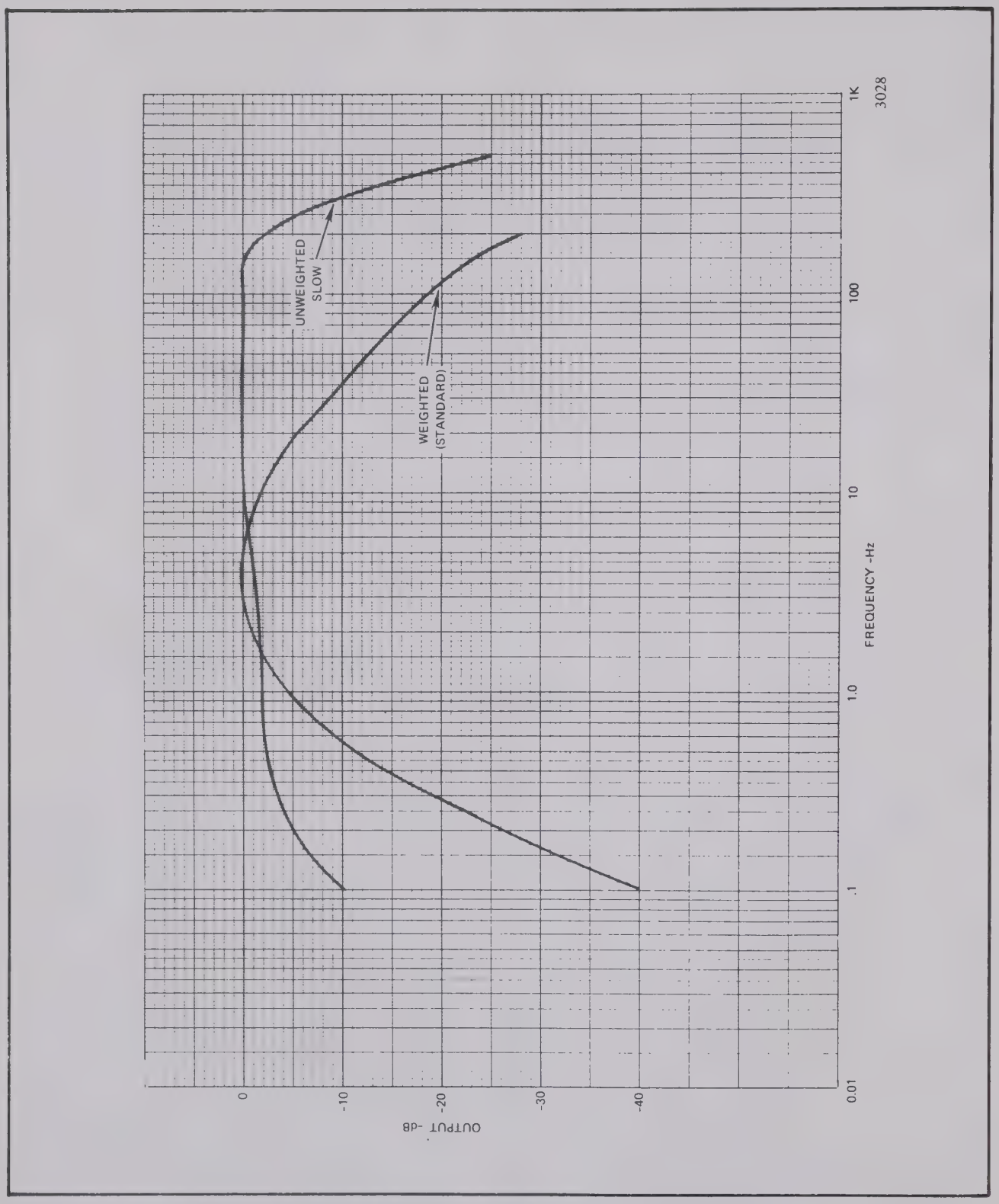


Figure 4-8. Frequency Response 8155A-IEEE

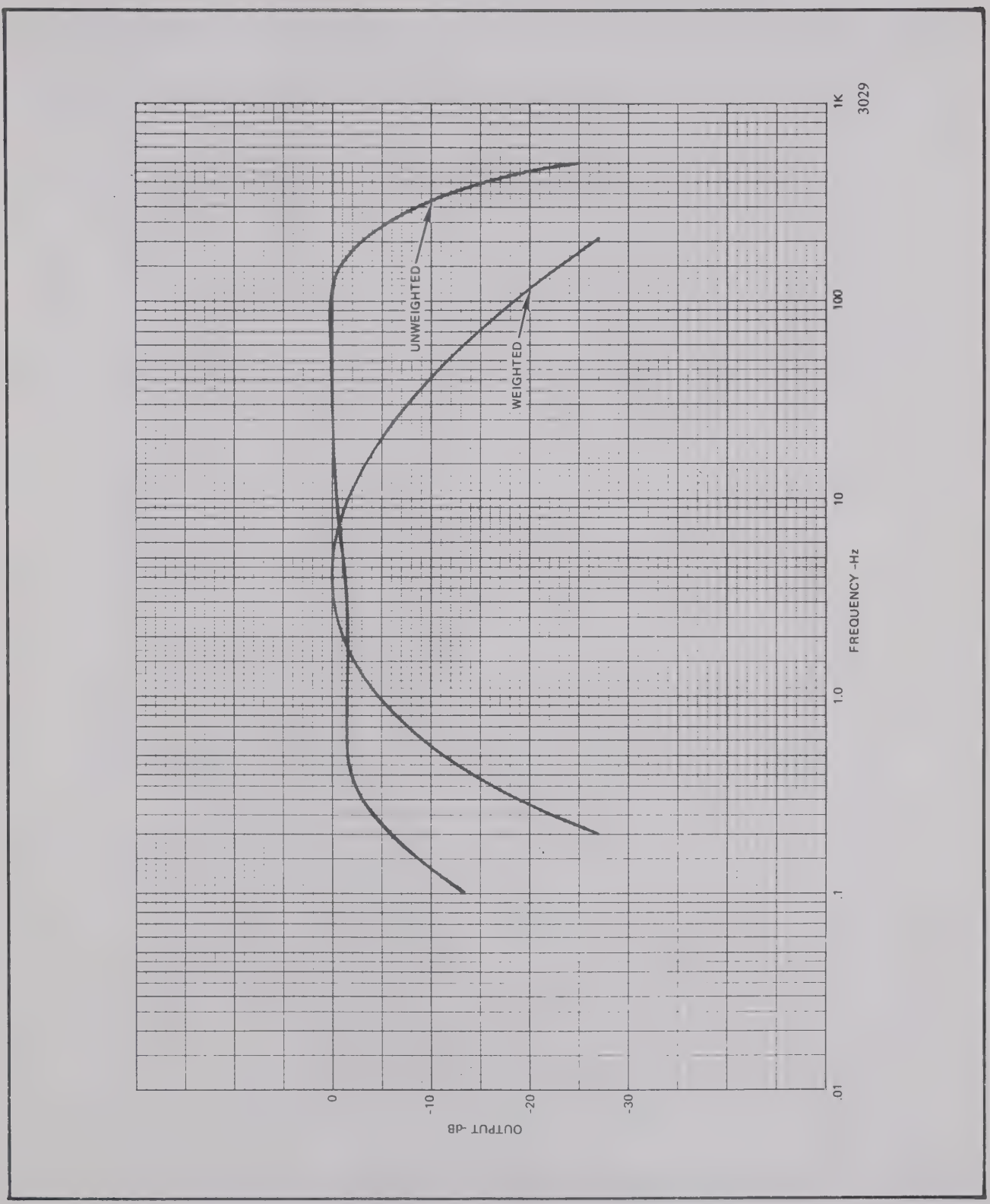


Figure 4-9. Frequency Response 8155A - NAB

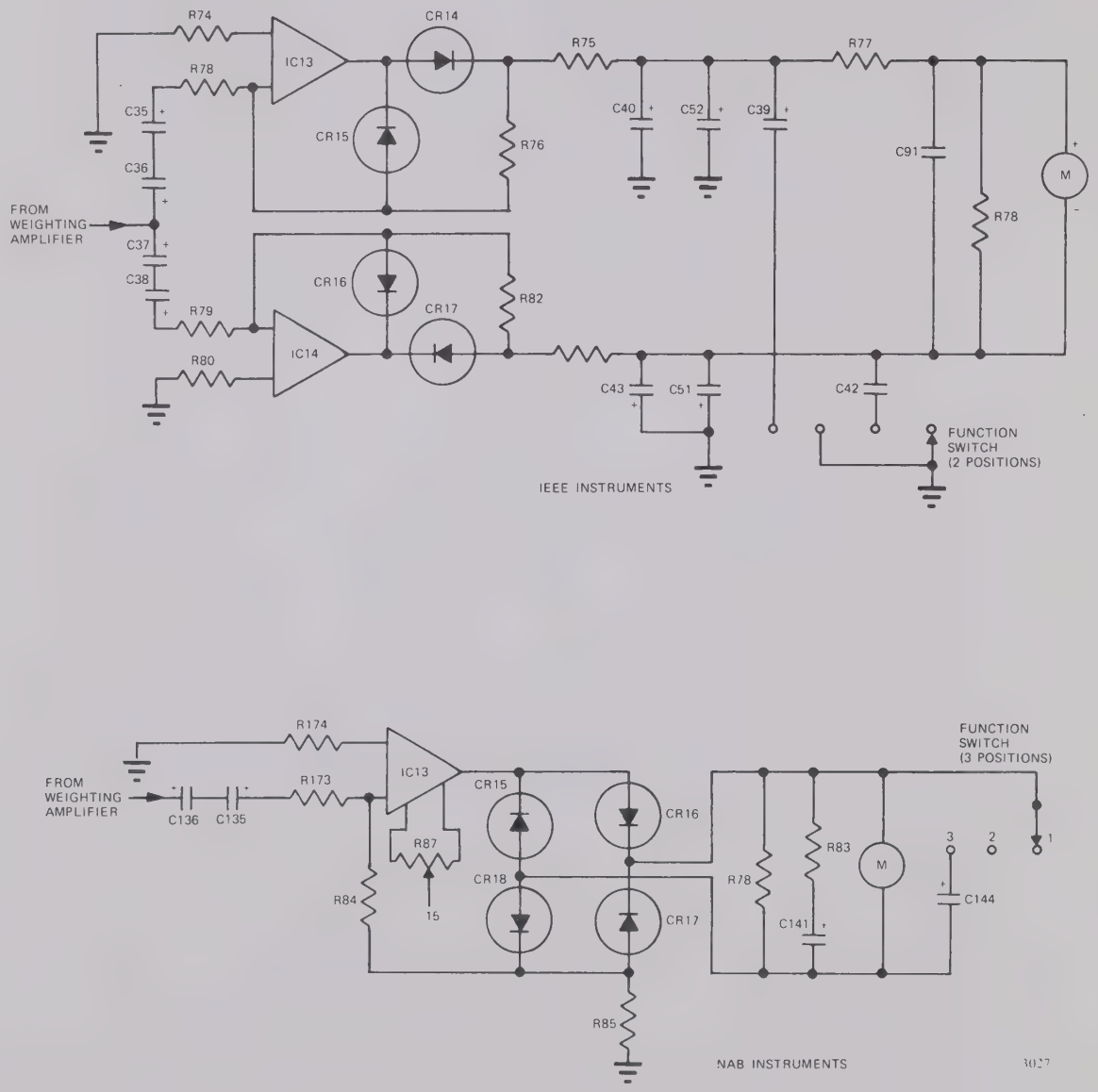


Figure 4-10. Meter Amplifier Circuitry

NAB Meter Amplifier Circuitry. In NAB instruments only IC13 is used. The meter circuit is changed from a peak-to-peak to an rms, full wave type. Resistors R78 and R83 and capacitor C141 provide for the VU meter characteristic. Capacitor C144 is switched in (via the function switch) when a highly damped or SLOW characteristic is desired. Potentiometer R87 is used to compensate the "Offset" of the amplifier to eliminate a residual meter reading.

SECTION V
MAINTENANCE

GENERAL

The Model 8155A Flutter Meter, a precision solid state test instrument, has been designed to provide long, trouble-free service without maintenance or adjustment. If a malfunction in the flutter meter should occur, follow the procedures in this section to troubleshoot and correct the problem. Note, however, that the recalibration of the flutter meter may require the use of certain test instruments which are not normally available except in the larger laboratories. If there is no access to such instruments, notify Mincom (see inside front cover) then return the flutter meter to the factory for prompt repair or recalibration.

TEST EQUIPMENT REQUIRED

The test equipment recommended for servicing the Model 8155A Flutter Meter is listed in Table 5-1. Other instruments may be used if their specifications and performance equal or exceed those of the instruments recommended.

Table 5-1. Recommended Test Equipment

INSTRUMENT	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
DC VTVM	100 mv to 1000 v, 0.2% full-scale accuracy	HP Model 3430A
AC VTVM	1 mv to 300v, 1.0% full-scale accuracy	HP Model 400EL
Oscillator	0.1 Hz to 10 kHz	Wavetek Model 111
Electronic Counter	5 Hz to 10 MHz, 0.1 to 10-second gate, 0.001% accuracy	HP Model 5221B
Precision Frequency Modulator	3.0 to 3.150 kHz $\pm$10% center frequency, 10% modulation range with 0.1% linearity.	Wavetek Model 111
Oscilloscope	10 mv/div. to 10v/div., dc to 15 MHz	Tektronix Model 422

ADJUSTMENT/ALIGNMENT

The adjustment/alignment procedure is presented as a complete alignment sequence for the Model 8155A Audio Flutter Meter. The steps are inter-related and should be performed in the sequence indicated. Figure 5-1 provides location data for the various adjustments referenced in the procedure. Access to the adjustments is obtained by removing the top cover of the instrument (secured by four countersunk Phillips-head screws).

The procedure is as follows:

1. Before applying power, perform a mechanical zero adjustment on the indicator meter. (Access to this adjustment is by means of a hole in the front panel.)

2. Apply power to the instrument.

3. Connect a frequency counter to the OSC OUTPUT connector. The counter readout shall be 3150 ±6 Hz for ~~IEEE/DIN~~ instruments or 3000 Hz ±6 Hz for NAB instruments. If necessary, adjust potentiometer R16 to obtain the correct output frequency. (Disconnect counter.)

4. Connect an AC VTVM to the OSC OUTPUT connector. Adjust potentiometer R20 to obtain an output level of 1.0 volt rms. (Disconnect AC VTVM.)

5. Jumper the OSC OUTPUT connector to the SIGNAL INPUT connector. NORM LIGHT COME

6. Set the range sensitivity switch to the .03% position.

7. Connect a DC VTVM to pin 6 (E11 on PCB) of IC11.

8. Adjust potentiometer R95 to obtain a zero volt indication. (Disconnect DC VTVM and remove jumper.)

NOTE

Step 9 is applicable to NAB instruments only. For IEEE/DIN instruments proceed directly to step 10.

9. Connect a jumper from the plus (+) side of capacitor C36 to ground. Allow the meter to settle, then adjust potentiometer R87 as required to obtain a minimum meter deflection. (Remove jumper.)

10. Set the function switch to ~~STD on IEEE/DIN~~ instruments or WTD on NAB instruments.

11. Set range sensitivity switch to 10% position.

12. Apply a 3150 or 3000 Hz carrier signal (as applicable to the test instrument configuration) which is being modulated to a 10% level by a 4 Hz sinewave.

13. Adjust potentiometer R69 as required to obtain a full scale meter indication at peak readings. (Disconnect input signal.)

14. Set function switch to UNWTD position. (Range sensitivity switch still at 10% position.)

15. Apply a 3150 or 3000 Hz carrier signal (as applicable to the test instrument configuration) which is being modulated to a 10% level by a 40 Hz sinewave.

16. Adjust potentiometer R70 as required to obtain a full scale meter indication at peak readings.

17. Connect AC VTVM to FLUTTER OUTPUT connector. Adjust potentiometer R71 to obtain a level indication of 100 millivolts rms. (Disconnect VTVM and input signal.)

18. Set range sensitivity switch to 1% position. (Function switch still in UNWTD position.)

19. Rotate the self-test switch clockwise to the TEST position and hold.

20. Adjust potentiometer R11 as required to obtain a full scale meter indication. (Release self-test switch.)

21. Step 20 completes the adjustment/alignment sequence. Replace the top cover on the instrument and return to use.

8155A FLUTTER METER

METHOD FOR CALIBRATION OF RANGE SENSITIVITY
BEGINNING WITH STEP 10 OF MANUAL (PAGE 23)
NAB SWITCH TO WTD

% FS RMS SWITCH TO 10%

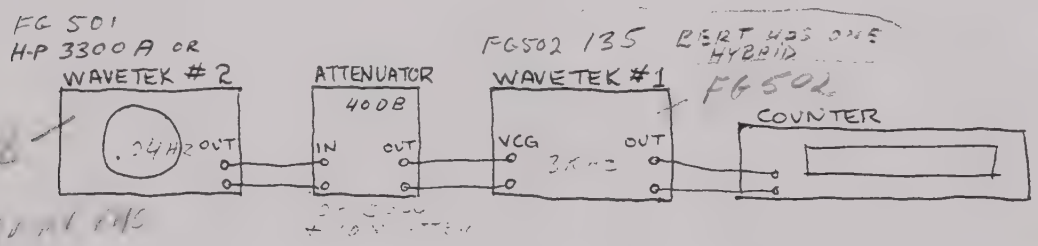
APPLY A 3000 HZ CARRIER SIGNAL WHICH IS BEING MODULATED TO A 10% LEVEL BY A 4 HZ SINE-WAVE:

EQUIPMENT REQUIRED

#1 WAVETEK 111 (VCG)
#2 WAVETEK 110
H/P 350D ATTENUATOR
H/P 5223L COUNTER

SET UP WAVETEK #1 FOR A 3000 HZ SINEWAVE OUTPUT CONNECTED TO THE COUNTER

SET UP WAVETEK #2 FOR A .04 HZ SQUARE WAVE OUTPUT CONNECTED THRU THE ATTENUATOR TO THE VCG INPUT OF WAVE TEK #1



ADJUST WAVETEK #2 ATTEN CONTROL AND ATTENUATOR FOR FREQUENCY LEVELS OF 2577 HZ AND 3423 HZ (+ AND - 14.1% MODULATION) PAY PARTICULAR ATTENTION TO THE DC OFFSET OF THE WAVETEK #2 AND ADJ IF NECESSARY. SET FREQS TO ± 3%.

SWITCH THE CONTROLS OF WAVE TEK #2 TO SINE-WAVE AND 4.0 HZ WITHOUT ADJUSTING ANY OTHER CONTROLS. CONNECT OUTPUT OF WAVE TEK #1 FROM COUNTER TO FLUTTER METER SIGNAL INPUT. METER SHOULD READ FS, 10% RMS. (AT PEAKS)
ON WTD ADJ. R69

SWITCH WAVETEK #2 TO 40.0 HZ WITHOUT ADJUSTING ANY OTHER CONTROLS. SWITCH NAB SWITCH ON FLUTTER METER TO UNWTD. METER SHOULD READ F/S 10% RMS.
ADJ. R70

CONSULT FLUTTER METER MANUAL FOR ADJUSTMENTS
CONTINUE WITH STEP 11 IN MANUAL

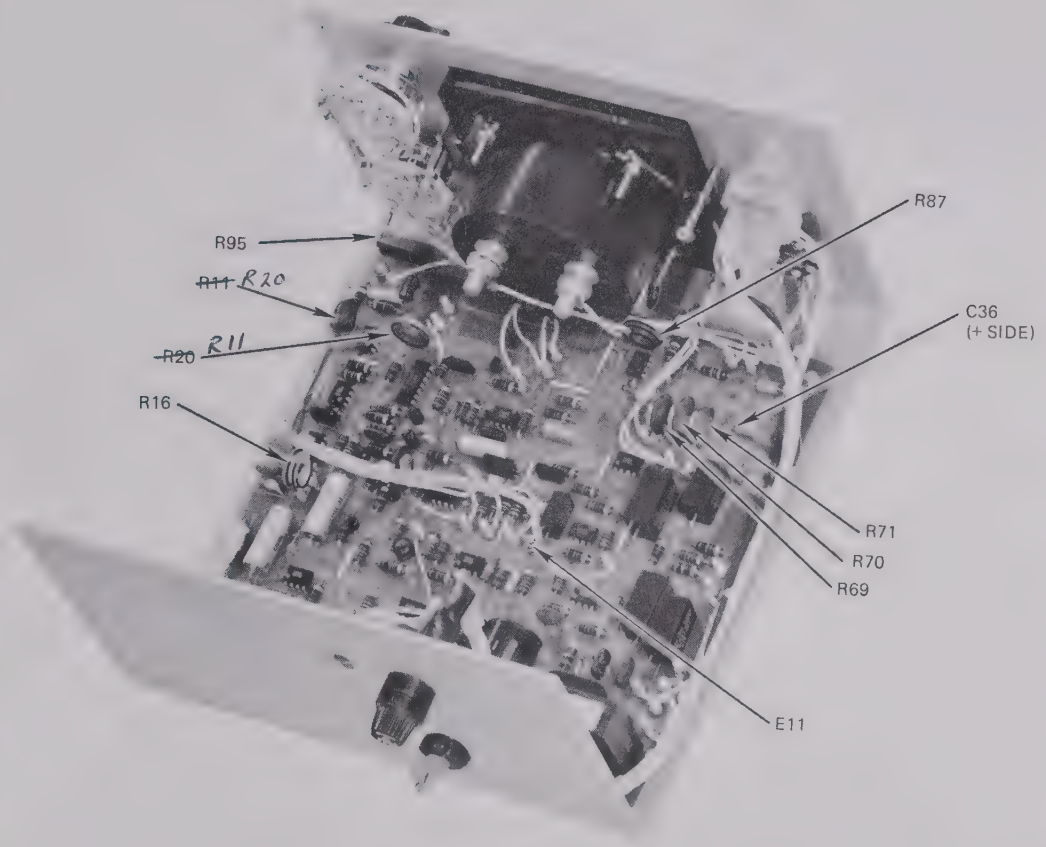


Figure 5-1. Adjustment Location

SECTION VI
SCHEMATICS

GENERAL

Table 6-1 tabulates the schematic diagrams provided to support operation and maintenance of the Model 8155A Audio Flutter Meter.

Table 6-1. List of Schematics

FIGURE NO.	TITLE	DRAWING NO.
6-1	Schematic, Audio Flutter Meter, IEEE	8155-0001-10
6-2	Schematic, Audio Flutter Meter, NAB	8155-0001-20

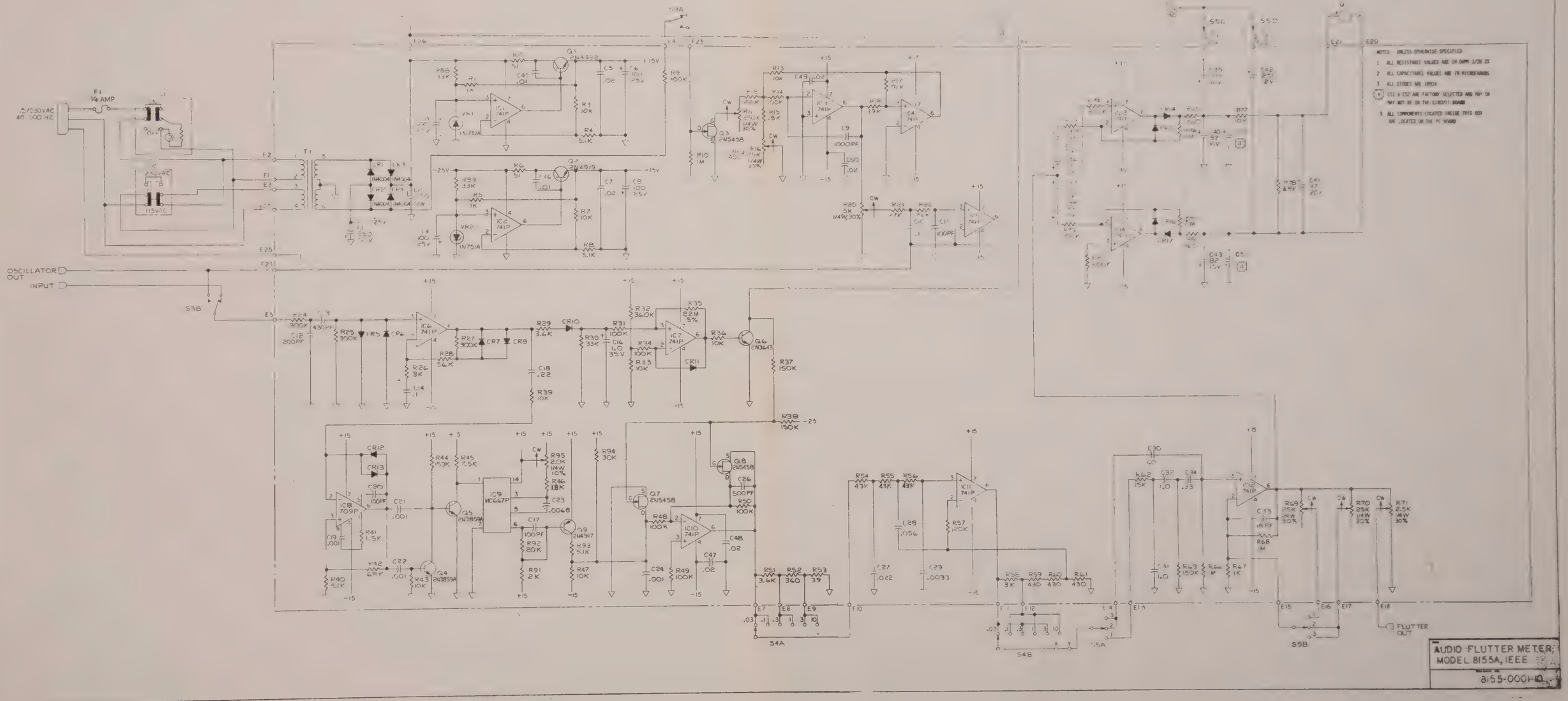


Figure 6-1. Schematic, Audio Flutter Meter, IEEE

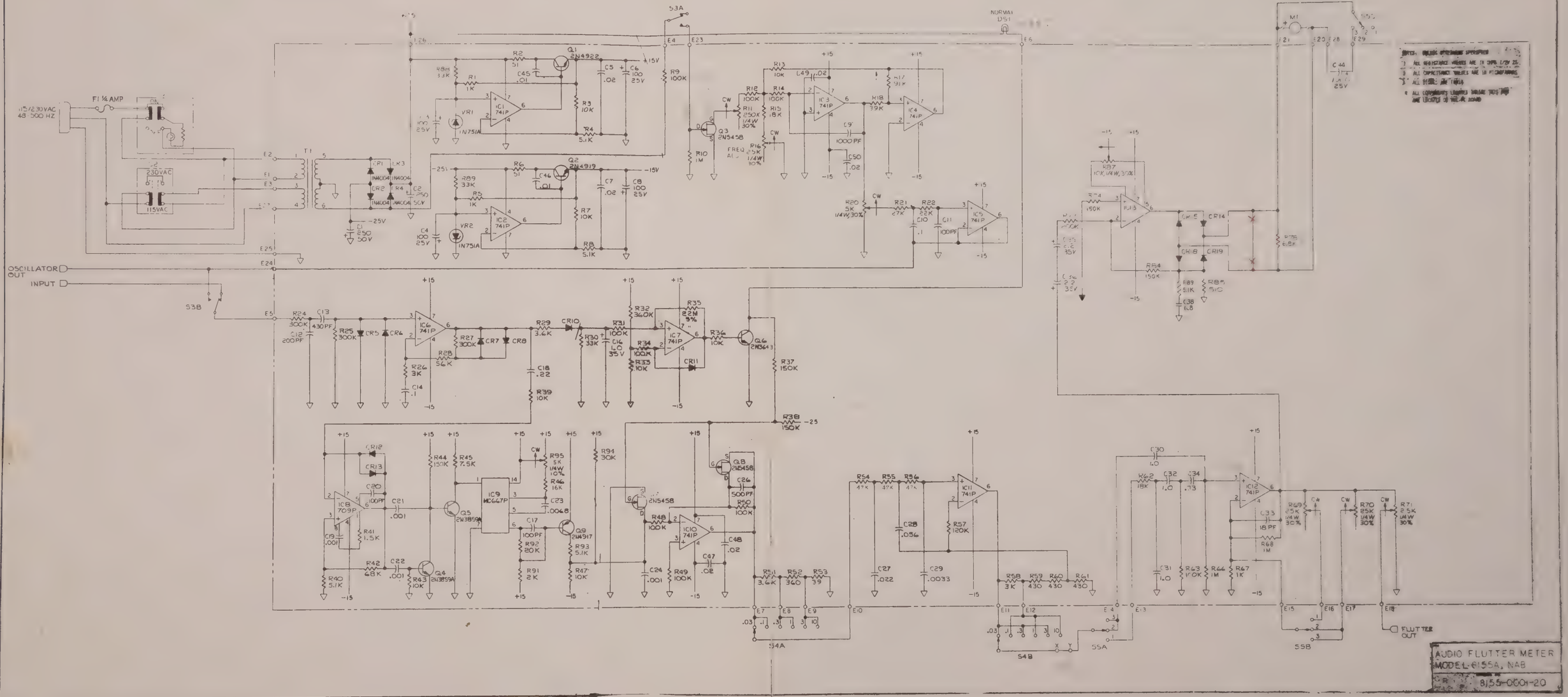


Figure 6-2. Schematic, Audio Flutter Meter, NAB

SECTION VII
PARTS LISTS

GENERAL

The parts lists tabulated in table 7-1 contain the information required for ordering replacement parts. Be certain to use those parts lists applicable to the instrument configuration (IEEE or NAB).

Table 7-1. List of Parts Lists

ASSEMBLY NO.	TITLE	PAGE NO.
8155-0000-10	Audio Flutter Meter, Model 8155, IEEE	
8155-0210-10	PCB Assembly, 8155A Flutter Meter, IEEE	
8155-0000-20	Audio Flutter Meter, Model 8155, NAB	
8155-0210-20	PCB Assembly, 8155A Flutter Meter, NAB	

3M Mincom Division — MINNESOTA MINING AND MANUFACTURING CO	PARTS LIST	12578 CODE IDENT	PL 8155-0000-10	A REV
	TITLE: AUDIO FLUTTER METER MODEL 8155A, IEEE		CAT. NO. 83-5990-1288	

FIND NO.	DESIG	MFG NAME	MFG PART NO	NOMENCLATURE OR DESCRIPTION	CAT. NO.	QTY
	DS1	MURA	L28-40	LAMP-INCANDESCENT, 28V	83-1550-2603	1
	F1	LITTLEFUSE	312.125	FUSE- 1/4A, 3AG	83-7550-8032	1
	M1	TRIPLETT	52A-3314 SPECIAL	METER-FLUTTER, SPECIAL	83-1550-3180	1
	S1	UID	LRSW322-N-CR-E	SWITCH-ROCKER OFFSET HOUSING, DPDT	83-1550-5628	1
	S2	SWITCHCRAFT	46256LFR	SWITCH-SLIDE DPDT, 115-230V	83-1550-5287	1
	S3	OAK	399189-28	SWITCH-ROTARY, 1 SEC, 3 POS.	83-1550-5629	1
	S4	CENTRALAB	PA2003	SWITCH-ROTARY, 2 POL. 2-6 POS.	83-1550-5020	1
	S5	CENTRALAB	PA2015	SW-ROTARY, 1 SEC, 2-3 POS, 5 POL	83-1550-5630	1
	1	MINCOM	8155-3010-10	CHASSIS - 8155A	83-3310-1742	1
	2	MINCOM	8155-0210-10	PCB ASSY-8155A FLUTTER METER, IEEE	83-4930-3287	1
	3	BUCKEYE		FEET & BAIL ASSY-STAND 5 1/2 INCH	83-1270-0960	1
	4	MINCOM	8155-3000-10	COVER - 8155A	83-3310-1741	1
	5	KING	KC-79-43	CONNECTOR-RECEPTACLE, RF COAXIAL	83-1610-1706	1
	6	MURA	RLC-W	LENS-CAP, INDICATOR, WHITE	83-1550-1975	1
	8	TRIPLETT	13-239	BEZEL-INST MTG, METER	83-1290-0351	1
	9	LITTLEFUSE	342012	FUSEHOLDER-POST, 3AG FUSE	83-1620-0002	1

3M Mincom Division (MINNESOTA MINING AND MANUFACTURING CO)	PARTS LIST	12578 CODE IDENT	PL 8155-0000-10	A REV
	TITLE AUDIO FLUTTER METER MODEL 8155A, IEEE		CAT. NO. 83-5990-1288	

FIND NO.- DESIG	MFG NAME	MFG PART NO	NOMENCLATURE OR DESCRIPTION	CAT. NO.	QTY
10	BELDEN	17408B	CABLE ASSY-POWER, ELEC, 3 COND	83-1570-0374	1
11	HEYMAN	SR-6P-1	BUSHING-STR REL, CABLE	83-1690-0158	1
12	HH SMITH	1468	TERM STRIP-GNDING, 1/4 MTG	83-9630-0091	2
13	HH SMITH	1414-4	TERM STRIP-GNDING #4 MTG	83-9630-0085	1
14	HH SMITH	8700	SPACER-RND, PLAIN #4-40	83-1350-0817	1
15		MS24693-4	SCREW-MACH, FH, 4-40 X 3/8 SST	83-9260-0272	2
16			WASHER-LOCK, INT. TOOTH #4	83-9261-4203	2
17	BUCKEYE	PS-70PL-2	KNOB-CONTROL, ROUND .250 DIA	83-1270-0385	1
18	BUCKEYE	PS-70BL-2	KNOB-CONTROL, ROUND .718 DIA	83-1270-0628	2
19		MS24693-28	SCREW-MACH, FH, 6-32 X 1/2, SST	83-9260-0271	2
20		MS35206-215	SCREW-MACH, PAN HD, 4-40 X 3/8	83-9260-4515	6
21		MS35206-230	SCREW-MACH, PAN HD, 6-32 X 7/16	83-9260-4532	8
22			NUT-SMALL PATTERN, HEX, 4-40	83-9260-2201	4
23		MS27183-4	WASHER-FLAT, GENERAL PURPOSE #4	83-9261-4002	6
24		MS35338-41	WASHER-LOCK, SPLIT HELICAL #4	83-9261-4303	6
25		MS27183-6	WASHER-FLAT, GENERAL PURPOSE #6	83-9261-4004	2
26		MS35338-42	WASHER-LOCK, SPLIT #6	83-9261-4305	2

3M Mincom Division (MINNESOTA MINING AND MANUFACTURING CO)	PARTS LIST	12578 CODE IDENT	PL 8155-0210-10	A REV
	TITLE PCB ASSY, 8155A FLUTTER METER, IEEE		CAT. NO. 83-4930-3283	

FIND NO.- DESIG	MFG NAME	MFG PART NO	NOMENCLATURE OR DESCRIPTION	CAT. NO	QTY
C1,C2	Cornell/Dub	BR250-50	Cap-FXD, Elect 250 ufd 50V	83-1510-2031	2
C3,C4,C6,C8	Cornell/Dub	BR100-25	Cap-FXD, Elect 100 ufd 25V	83-1510-2025	4
C5,C7,C47,C48,C49, C50	Centralab	DDM-203	Cap-FXD Cer .02 ufd 150V	83-1510-1008	6
C9	Arco	DM15F102F	Cap-FXD Mica 1000 pfd 100V 1%	83-1510-5302	1
C10		112A1A104M	Cap-FXD-Paper .1 ufd 50V	83-1510-4185	1
C11,C17,C20	0A836-5155		Cap-FXD, Mica 100 pf 500V 5%	83-1510-5155	3
C12	0A836-5214		Cap-FXD, Mica 200 pf 500V 5%	83-1510-5214	1
C13	0A836-5119		Cap-FXD, Mica 430 pf 500V 5%	83-1510-5119	1
C14	Centralab	UK10-104	Cap-FXD, Cer .1 ufd 10V	83-1510-1077	1
C16	Ci	CS138F105K	Cap-FXD, Ta 1.0ufd, 35V, 10%	83-1510-6111	1
C18		112A1C224	Cap-FXD, Paper .22 ufd 200V 20%	83-1510-4183	1
C19,C21,C22,C24	RMC	SM-210	Cap-FXD, Cer .001 ufd	83-1510-1108	4
C23		E3FR-682-1C	Cap-FXD, Pistc .0068 ufd 100V 5%	83-1510-4447	1
C26	RMC	GP350-RMCJF500	Cap-FXD-Cer 500 pf 1000V	83-1510-1104	1
C27	0A839-4459		Cap-FXD .022 ufd 200V 5%	83-1510-4459	1
C28	0A839-4002		Cap-FXD My .056 ufd 200V 5%	83-1510-4002	1
C29		E3FR-332-1C	Cap-FXD Plstc .0033 ufd 100V 5%	83-1510-4445	1
C30,C31,C32		E3XF-105-1C	Cap-FXD Plstc 1.0 ufd 100V 5%	83-1510-4441	3

3M Mincom Division (MINNESOTA MINING AND MANUFACTURING CO)	PARTS LIST	12578 CODE IDENT	PL 8155-0210-10	A REV
	TITLE PCB ASSY, 8155A FLUTTER METER, IEEE		CAT. NO. 83-4930-3287	

FIND NO.- DESIG	MFG NAME	MFG PART NO	NOMENCLATURE OR DESCRIPTION	CAT. NO.	QTY
C33	0A836-5242		Cap-FXD, Mica 18 pf 500V 5%	83-1510-5242	1
C34	0A839-6033		Cap-FXD Plstc .33 ufd 100V 5%	83-1510-6033	1
C35,C36,C37,C38	C1	CS13BF225K	Cap-FXD Ta 2.2ufd, 35V, 10%	83-1510-6093	4
C39,C42	0A860-2109		Cap-FXD Elect 250 ufd 12V	83-1510-2109	2
C40,C43		CCZ-010-826-10	Cap-FXD Ta 82 ufd 10V	83-1510-6442	2
C41		CCZ-020-476-10	Cap-FXD, Ta 47 ufd 20V	83-1510-6438	1
C45,C46	Centralab	DDM-103	Cap-FXD Cer .01 ufd 150V	83-1510-1048	2
CR1,2,3,4	Motorola	1N4004	Diode-Si-Diff Jct 400V 1 Amp	83-1530-0151	4
CR5,6,7,8,10,11,12, CR13,14,15,16,17		1N914	Diode-Si-Switching 100V	83-1530-0083	12
IC1,2,3,4,5,6,7,10, IC11,12,13,14	Texas Inst.	741P	Int Cir OP Amp	83-1530-8159	12
IC8	Texas Inst.	709P	Int Cir OP Amp	83-1530-8160	1
IC9	Motorola	MC667P	Int Cir Monostable MV Dual	83-1530-8196	1
Q1	Motorola	2N4922	Tstr-Si-NPN, Plastic, Med Pwr	83-1530-2420	1
Q2	Motorola	2N4919	Tstr-Si-PNP, Plastic, Med Pwr	83-1530-2421	1
Q3,Q7,Q8	Motorola	2N5458	Tstr-Si-FET-N-Channel, Sw	83-1530-2408	3

3M Mincom Division (MINNESOTA MINING AND MANUFACTURING CO)	PARTS LIST	12578 CODE IDENT	PL 8155-0210-10	A REV
	TITLE PCB ASSY, 8155A FLUTTER METER, IEEE		CAT. NO. 83-4930-3287	

FIND NO DESIG	MFG NAME	MFG PART NO	NOMENCLATURE OR DESCRIPTION	CAT NO	QTY
Q4,Q5	G.E.	2N3859A	Tstr-Si-NPN-L Pwr 75 HFE	83-1530-2261	2
Q6	Fairchild	2N3643	Tstr-Si-NPN-Switching 300 HFE	83-1530-2234	1
Q9	Fairchild	2N4917	Tstr-Si-PNP-Switching	83-1530-2317	1
R1,R5,R67	0A781-7175		Res-FXD Film 1K ohm 1/2W 2%	83-1520-7175	3
R2,R6	0A781-7222		Res-FXD Film 51 ohm 1/2W 2%	83-1520-7222	2
R3,7,13,33,36,39, R43,47,77	0A781-7148		Res-FXD Film 10K ohm 1/2W 2%	83-1520-7148	9
R4,R8,R40,R93	0A781-7142		Res-FXD Film 5.1K ohm 1/2W 2%	83-1520-7142	4
R9,12,14,31,34,48, R49,R50	0A781-7387		Res-FXD Film 100K ohm 1/2W 2%	83-1520-7387	8
R10,R66,R68		RL20G	Res-FXD Film 1M ohm 1/2W 2%	83-1520-8483	3
R11	CTS	X201R254B	Res-Variable, Cermet 250K ohm 1/4 W 30%	83-1520-1620	1
R15,R46	0A781-7146		Res-FXD Film 18K ohm 1/2W 2%	83-1520-7146	2
R16,R69,R70	CTS	X201RR53B	Res-Variable, Cermet 25K ohm 1/4 W 30%	83-1520-1619	3
R17	0A781-7386		Res-FXD Film 91K ohm 1/2W 2%	83-1520-7386	1
R18	0A781-7377		Res-FXD Film 39K ohm 1/2W 2%	83-1520-7377	1
R20	CTS	X201R502B	Res-Variable, Cermet 5K ohm 1/4 W 30%	83-1520-1434	1
R21	0A781-7373		Res-FXD Film 27K ohm 1/2W 2%	83-1520-7373	1

3M Mincom Division (MINNESOTA MINING AND MANUFACTURING CO)	PARTS LIST	12578 CODE IDENT	PL 8155-0210-10	A REV
	TITLE PCB ASSY, 8155A FLUTTER METER, IEEE		CAT. NO. 83-4930-3287	

FIND NO - DESIG	MFG NAME	MFG PART NO.	NOMENCLATURE OR DESCRIPTION	CAT. NO.	QTY
R22	0A781-7372		Res-FXD Film 22K ohm 1/2W 2%	83-1520-7372	1
R24 ,R25 ,R27	0A781-7394		Res-FXD Film 300K ohm 1/2W 2%	83-1520-7394	3
R26 ,R58	0A781-7219		Res-FXD Film 3K ohm 1/2W 2%	83-1520-7219	2
R28	0A781-7381		Res-FXD Film 56K ohm 1/2W 2%	83-1520-7381	1
R29 ,R51	0A781-7362		Res-FXD Film 3.6K ohm 1/2W 2%	83-1520-7362	2
R30 ,R88 ,R89	0A781-7375		Res-FXD Film 33K ohm 1/2W 2%	83-1520-7375	3
R32	0A781-7396		Res-FXD Film 360K ohm 1/2W 2%	83-1520-7396	1
R35			Res-FXD Comp 22M ohm 1/2W 5%	83-9520-3261	1
R37 ,R38 ,R63 ,R44	0A781-7143		Res-FXD Film 150K ohm 1/2W 2%	83-1520-7143	4
R41	0A781-7217		Res-FXD Film 1.5K ohm 1/2W 2%	83-1520-7217	1
R42	0A781-7383		Res-FXD Film 68K ohm 1/2W 2%	83-1520-7383	1
R45	0A781-7368		Res-FXD Film 7.5K ohm 1/2W 2%	83-1520-7368	1
R52 ,R75 ,R81	0A781-7351		Res-FXD Film 360 ohm 1/2W 2%	83-1520-7351	3
R53	0A781-7335		Res-FXD Film 39 ohm 1/2W 2%	83-1520-7335	1
R54 ,R55 ,R56	0A781-7378		Res-FXD Film 43K ohm 1/2W 2%	83-1520-7378	3
R57	0A781-7388		Res-FXD Film 120K ohm 1/2W 2%	83-1520-7388	1
R59 ,R60 ,R61	0A781-7352		Res-FXD Film 430 ohm 1/2W 2%	83-1520-7352	3

3M Mincom Division
(MINNESOTA MINING AND MANUFACTURING CO)

PARTS LIST

12578 CODE IDENT | PL 8155-0210-10 | A REV

TITLE: PCB ASSY, 8155A FLUTTER METER, IEEE

CAT. NO. 83-4930-3287

FIND NO.- DESIG	MFG NAME	MFG PART NO	NOMENCLATURE OR DESCRIPTION	CAT NO.	QTY
R62	0A781-7144		Res-FXD, Film 15K ohm 1/2W 2%	83-1520-7144	1
R71	CTS	X201R252B	Res-Variable, Cermet 2.5K ohm W 30%	83-1520-1618	1
R73,74,79,80	0A781-7390		Res-FXD Film 200K ohm 1/2W 2%	83-1520-7390	4
R76,R82		RN20X	Res-FXD Film 2M ohm 1/2W 1%	83-1520-8484	2
R78	0A781-7201		Res-FXD Film 1.8K ohm 1/2W 2%	83-1520-7201	1
R91	0A781-7263		Res-FXD Film 2.0K ohm 1/2W 2%	83-1520-7263	1
R92	0A781-7371		Res-FXD Film 20K ohm 1/2W 2%	83-1520-7371	1
R94	0A781-7374		Res-FXD Film 30K ohm 1/2W 2%	83-1520-7374	1
R95	0A818-1534		Res-Variable, Cermet 2.0K ohm .75W 10%	83-1520-1534	1
T1	Signal Trans	7152	Transformer Power Pri. 115/230, Sec 40V CT	83-1540-1360	1
VR1,VR2		1N751A	Diode Zener 5.1V 5% 400 MW	83-1530-0133	2
1	Mincom	8155-0205-01	PCB-8155A, Flutter Meter	83-3640-2101	1
2	Mincom	07301A067	Heat Sink	83-3690-0387	2

3M Mincom Division (MINNESOTA MINING AND MANUFACTURING CO.)	PARTS LIST	12578 CODE IDENT	PL 8155-0000-20	A REV
	TITLE AUDIO FLUTTER METER MODEL 8155A, NAB		CAT. NO. 83-5990-1289	

FIND NO.- DESIG	MFG NAME	MFG PART NO.	NOMENCLATURE OR DESCRIPTION	CAT. NO.	QTY
DS1	MURA	L28-40	LAMP-INCANDESCENT, 28V	83-1550-2603	1
F1	LITTLEFUSE	312.125	FUSE- 1/4A, 3AG	83-7550-8032	1
M1	TRIPLETT	52A-3314 SPECIAL	METER-FLUTTER, SPECIAL	83-1550-3180	1
S1	UID	LRSW322-N-CR-E	SWITCH-ROCKER OFFSET HOUSING	83-1550-5628	1
S2	SWITCHCRAFT	46256LFR	SWITCH-SLIDE DPDT, 115-230V	83-1550-5287	1
S3	OAK	399189-28	SWITCH-ROTARY, 1 SEC, 3 POS	83-1550-5629	1
S4	CENTRALAB	PA2003	SWITCH-ROTARY, 2 POL, 2-6 POS	83-1550-5020	1
S5	CENTRALAB	PA2015	SW-ROTARY, 1 SEC, 2-3 POS, 5 POL	83-1550-5630	1
1	MINCOM	8155-3010-10	CHASSIS - 8155A	83-3310-1742	1
2	MINCOM	8155-0210-20	PCB ASSY-8155A FLUTTER METER, NAB	83-4930-3288	1
3	BUCKEYE		FEET & BAIL ASSY-STAND 5 1/2 INCH	83-1270-0960	1
4	MINCOM	8155-3000-10	COVER - 8155A	83-3310-1741	1
5	KING	KC-79-43	CONNECTOR-RECEPTACLE, RF COAXIAL	83-1610-1706	3
6	MURA	RLC-W	LENS-CAP, INDICATOR, WHITE	83-1550-1975	1
8	TRIPLETT	13-239	BEZEL-INST MTG, METER	83-1290-0351	1
9	LITTLEFUSE	342012	FUSEHOLDER-POS, 3AG FUSE	83-1620-0002	1
10	BELDEN	17408B	CABLE ASSY-POWER, ELEC, 3 COND	83-1570-0374	1
11	HEYMAN	SR-6P-1	BUSHING-STR REL, CABLE	83-1690-0158	1
12	HH SMITH	1468	TERM STRIP-GNDING, 1/4 MTG	83-9630-0091	2

3M Mincom Division (MINNESOTA MINING AND MANUFACTURING CO)	PARTS LIST	12578 CODE IDENT	PL 8155-0000-20	A REV
	TITLE: AUDIO FLUTTER METER MODEL 8155A, NAB		CAT. NO. 83-5990-1289	

FIND NO. - DESIG	MFG NAME	MFG PART NO	NOMENCLATURE OR DESCRIPTION	CAT NO	QTY
13	HH SMITH	1414-4	TERM STRIP-GNDING #4 MTG	83-9630-0085	1
14	HH SMITH	8700	SPACER-RND, PLAIN #4-40	83-1350-0817	1
15		MS24693-4	SCREW-MACH, FH, 4-40 X 3/8 SST	83-9260-0272	2
16			WASHER-LOCK, INT. TOOTH #6	83-9261-4203	2
17	BUCKEYE	PS-70PL-2	KNOB-CONTROL, ROUND .250 DIA	83-1270-0385	1
18	BUCKEYE	PS-70BL-2	KNOB-CONTROL, ROUND .718 DIA	83-1270-0628	2
19		MS24693-28	SCREW-MACH, FH, 6-32 X 1/2, SST	83-9260-0271	2
20		MS35206-215	SCREW-MACH, PAN HD, 4-40 X 3/8	83-9260-4515	6
21		MS35206-230	SCREW-MACH, PAN HD, 6-32 X 7/16 -	83-9260-4532	8
22			NUT-SMALL PATTERN, HEX, 4-40	83-9260-2201	4
23		MS27183-4	WASHER-FLAT, GENERAL PURPOSE #4	83-9261-4002	6
24		MS35338-41	WASHER-LOCK, SPLIT HELICAL #4	83-9261-4303	6
25		MS27183-6	WASHER-FLAT, GENERAL PURPOSE #6	83-9261-4004	2
26		MS35338-42	WASHER-LOCK, SPLIT #6	83-9261-4305	2
27	MINCOM	8155-3050-00	PLATE-I.D., NAB	83-3550-2134	1

3M Mincom Division MINNESOTA MINING AND MANUFACTURING CO.	PARTS LIST	12578 CODE IDENT	PL 8155-0210-20 SHEET 2 OF 6	A REV
	TITLE PCB ASSY, 8155A FLUTTER METER - NAB		CAT. NO. 83-4930-3288	

FIND NO.- DESIG	MFG NAME	MFG PART NO.	NOMENCLATURE OR DESCRIPTION	CAT. NO.	QTY
C1,C2	CORNELL/DUB	BR250-50	CAP-FXD, ELECT 250 UFD 50V	83-1510-2031	2
C3,C4,C6,C8	CORNELL/DUB	BR100-25	CAP-FXD, ELECT 100 UFD 25V	83-1510-2025	4
C5,C7,C47,C48,C49,	CENTRALAB	DDM-203	CAP-FXD CER .02 UFD 150V	83-1510-1008	6
C50					
C9	ARCO	DM15F102F	CAP-FXD MICA 1000 PFD 100V 1%	83-1510-5302	1
C10		112A1A104M	CAP-FXD-PAPER .1 UFD 50V	83-1510-4185	1
C11,C20,C17	0A836-5155		CAP-FXD, MICA 100 PF 500V 5%	83-1510-5155	3
C12	0A836-5214		CAP-FXD, MICA 200 PF 500V 5%	83-1510-5214	1
C13	0A836-5119		CAP-FXD, MICA 430 PF 500V 5%	83-1510-5119	1
C14	CENTRALAB	UK10-104	CAP-FXD, CER .1 UFD 10V	83-1510-1077	1
C16	CI	CCM-035-105-10	CAP-FXD, TA 1 UFD 35V	83-1510-6413	1
C18		112A1C224	CAP-FXD, PAPER .22 UFD 200V 20%	83-1510-4183	1
C19,C21,C22,C24	RMC	SM-210	CAP-FXD, CER .001 UFD	83-1510-1108	4
C23		E3FR-682-1C	CAP-FXD PLSTC .0068 UFD 100V 5%	83-1510-4447	1
C26	RMC	GP350-RMCJF500	CAP-FXD, CER 500 PF 1000V	83-1510-1104	1
C27	0A839-4459		CAP-FXD .022 UFD 200V 5%	83-1510-4459	1
C28	0A839-4002		CAP-FXD MY .056 UFD 200V 5%	83-1510-4002	1
C29		E3FR-332-1C	CAP-FXD PLSTC .0033 UFD 100V 5%	83-1510-4445	1
C30,C31,C32		E3XF-105-1C	CAP-FXD PLSTC 1.0 UFD 100V 5%	83-1510-4441	3

3M Mincom Division — MINNESOTA MINING AND MANUFACTURING CO	PARTS LIST	12578 CODE IDENT	PL 8155-0210-20	A REV
	TITLE PCB ASSY, 8155A FLUTTER METER - NAB		CAT. NO. 83-4930-3288	

FIND NO.- DESIG	MFG NAME	MFG PART NO.	NOMENCLATURE OR DESCRIPTION	CAT NO.	QTY
C33	0A836-5242		CAP-FXD MICA 18 PF 500V 5%	83-1510-5242	1
C34	0A839-6033		CAP-FXD MY .33 UFD 200V 5%	83-1510-6033	1
C35,C36	CI	CCL-035-225-10	CAP-FXD, TA 2.2 UFD 35V	83-1510-6415	2
C38			CAP-FXD. TA 6.8UFD 35V 10%	83-1510-6144	1
C44	SPRAGUE	39D108G010FJ4	CAP-FXD, ELECT, 1000 UFD 10V	83-1510-2316	1
C45,C46	CENTRALAB	DDM-103	CAP-FXD CER .01 UFD 150V	83-1510-1048	2
CR1,CR2,CR3,CR4	MOTOROLA	1N4004	DIODE-SI-DIFF JCT 400V 1 AMP	83-1530-0151	4
CR5,6,7,8,10,11,12		1N914	DIODE-SI-SWITCHING 100V	83-1530-0083	12
CR13,14,15,18,19					
IC1,2,3,4,5,6,7,10,	TEXAS INST.	741P	INT CIR-OP AMP	83-1530-8159	11
IC11,12,13					
IC8	TEXAS INST.	709P	INT CIR-OP AMP	83-1530-8160	1
IC9	MOTOROLA	MC667P	INT CIR-MONOSTABLE MV DUAL	83-1530-8196	1
Q1	MOTOROLA	2N4922	TSTR-SI-NPN, PLASTIC, MED PWR	83-1530-2420	1

3M Mincom Division
MINNESOTA MINING AND MANUFACTURING CO

PARTS LIST

12578 CODE IDENT | PL 8155-0210-20 | A REV

TITLE: PCB ASSY, 8155A FLUTTER METER - NAB

CAT. NO. 83-4930-3288

FIND NO. - DESIG	MFG NAME	MFG PART NO.	NOMENCLATURE OR DESCRIPTION	CAT NO.	QTY
Q2	MOTOROLA	2N4919	TSTR-SI-PNP, PLASTIC, MED PWR	83-1530-2421	1
Q3,Q7,Q8	MOTOROLA	2N5458	TSTR-SI-FET-N-CHANNEL, SW	83-1530-2408	3
Q4,Q5	GE	2N3859A	TSTR-SI-NPN-L PWR 75 HFE	83-1530-2261	2
Q6	FAIRCHILD	2N3643	TSTR-SI-NPN-SWITCHING 300 HFE	83-1530-2234	1
Q9	FAIRCHILD	2N4917	TSTR-SI-PNP-SWITCHING	83-1530-2317	1
R1,R5,R67	0A781-7175		RES-FXD FILM 1K OHM 1/2W 2%	83-1520-7175	3
R2,R6	0A781-7222		RES-FXD FILM 51 OHM 1/2W 2%	83-1520-7222	2
R3,R7,R13,R33,R36,	0A781-7148		RES-FXD FILM 10K OHM 1/2W 2%	83-1520-7148	8
R39,R43,R47					
R4,R8,R79,R93	0A781-7142		RES-FXD FILM 5.1K OHM 1/2W 2%	83-1520-7142	5
R9,R12,R14,R31,R34,	0A781-7387		RES-FXD FILM 100K OHM 1/2W 2%	83-1520-7387	9
R48,R49,R50,R63					
R10,R66,R68		RL20G	RES-FXD FILM 1M OHM 1/2W 2%	83-1520-8483	3
R11	CTS	X201R254B	RES-VARIABLE, CERMET 250K OHM 1/4W 30%	83-1520-1620	1
R15,R62	0A781-7146		RES-FXD FILM 18K OHM 1/2W 2%	83-1520-7146	2
R16,R69,R70	CTS	X201RR53B	RES-VARIABLE, CERMET 25K OHM 1/4W 30%	83-1520-1619	3
R17	0A781-7386		RES-FXD FILM 91K OHM 1/2W 2%	83-1520-7386	1
R18	0A781-7377		RES-FXD FILM 39K OHM 1/2W 2%	83-1520-7377	1

3M Mincom Division (MINNESOTA MINING AND MANUFACTURING CO)	PARTS LIST	12578 CODE IDENT	PL 8155-0210-20	A REV
	TITLE PCB ASSY, 8155A FLUTTER METER - NAB		CAT. NO. 83-4930-3288	

FIND NO. DESIG	MFG NAME	MFG PART NO.	NOMENCLATURE OR DESCRIPTION	CAT. NO.	QTY
R20	CTS	X201R503B	RES-VARIABLE, CERMET 5K OHM 1/4W 30%	83-1520-1434	1
R21	0A781-7373		RES-FXD FILM 27K OHM 1/2W 2%	83-1520-7373	1
R22	0A781-7372		RES-FXD FILM 22K OHM 1/2W 2%	83-1520-7372	1
R24,R25,R27	0A781-7394		RES-FXD FILM 300K OHM 1/2W 2%	83-1520-7394	3
R26,R58	0A781-7219		RES-FXD FILM 3K OHM 1/2W 2%	83-1520-7219	2
R28	0A781-7381		RES-FXD FILM 56K OHM 1/2W 2%	83-1520-7381	1
R29,R51	0A781-7362		RES-FXD FILM 3.6K OHM 1/2W 2%	83-1520-7362	2
R30,R88,R89	0A781-7375		RES-FXD, FILM 33K OHM 1/2W 2%	83-1520-7375	3
R32	0A781-7396		RES-FXD FILM 360K OHM 1/2W 2%	83-1520-7396	1
R35			RES-FXD COMP 22M OHM 1/2W 5%	83-9520-3261	1
R37,R38,R74,R84	0A781-7143		RES-FXD FILM 150K OHM 1/2W 2%	83-1520-7143	4
R41	0A781-7217		RES-FXD FILM 1.5K OHM 1/2W 2%	83-1520-7217	1
R42	0A781-7383		RES-FXD FILM 68K OHM 1/2W 2%	83-1520-7383	1
R44	0A781-7384		RES-FXD FILM 75K OHM 1/2W 2%	83-1520-7384	1
R45	0A781-7368		RES-FXD FILM 7.5K OHM 1/2W 2%	83-1520-7368	1
R52	0A781-7351		RES-FXD FILM 360 OHM 1/2W 2%	83-1520-7351	1
R53	0A781-7335		RES-FXD FILM 39 OHM 1/2W 2%	83-1520-7335	1
R54,R55,R56	0A781-7378		RES-FXD FILM 47K ohm, 1/2W, 2%	83-1520-7379	3
R57	0A781-7388		RES-FXD FILM 120K OHM 1/2W 2%	83-1520-7388	1
R59,R60,R61	0A781-7352		RES-FXD FILM 430 OHM 1/2W 2%	83-1520-7352	3
R46			RES-FXD FILM 16K OHM 1/2W 2%	83-1520-0038	1

3M Mincom Division MINNESOTA MINING AND MANUFACTURING CO.	PARTS LIST	12578 CODE IDENT	PL 8155-0210-20	A REV
	TITLE PCB ASSY, 8155A FLUTTER METER - NAB		CAT. NO. 83-4930-3288	

FIND NO.- DESIG	MFG NAME	MFG PART NO.	NOMENCLATURE OR DESCRIPTION	CAT. NO.	QTY
R71	CTS	X201R252B	RES-VARIABLE, CERMET 2.5K OHM 1/4W 30%	83-1520-1618	1
R73	0A781-7390		RES-FXD FILM 200K OHM 1/2W 2%	83-1520-7390	1
R78	0A781-7201		RES-FXD FILM 6.8K OHM 1/2W 2%	83-1520-7367	1
R91	0A781-7263		RES-FXD, FILM 2K OHM 1/2W 2%	83-1520-7263	1
R85	0A781-7354		RES-FXD, FILM 510 OHM 1/2W 2%	83-1520-7354	1
R87	CTS	X201R103B	RES-VARIABLE, CERMET 10K OHM 1/4W 30%	83-1520-1556	1
R92	0A781-		RES-FXD, FILM 20K OHM 1/2W 2%	83-1520-7371	1
R94	0A781-		RES-FXD, FILM 30K OHM 1/2W 2%	83-1520-7374	1
R95	0A818-1534		RES-VARIABLE, CERMET 5K OHM 3/4W, 10%	83-1520-1535	1
T1	SIGNAL TRANS	7152	TRANSFORMER POWER PRI, 115/230, SEC 40V CT	83-1540-1360	1
VR1,VR2		1N751A	DIODE ZENER 5.1V 5% 400 MW	83-1530-0133	2
1	MINCOM	8155-0205-01	PCB - 8155A FLUTTER METER	83-3640-2101	1
2	MINCOM	07301A067	HEAT SINK	83-3690-0387	2

RECEIVING REPORT

Sundstrand Data Control, Inc.

Mincom, Inc.

PURCHASE ORDER

No. 11018

THIS NUMBER MUST APPEAR ON ALL INVOICES, PACKING SLIPS, PACKAGES & CORRESPONDENCE

TO . Mincom, Inc. 41400
Div. of 3-M Co.
300 S. Lewis Rd.
Camarillo, CA. 93010

SHIP TO: (SAME AS ABOVE UNLESS NOTED)

SHIP VIA: UPS Blue

BUYER: Fenner #3

OUR RESALE NO. C.600-039333 RESALE	TAXABLE	PRIORITY RATING	CONTRACT NUMBER	TERMS	F. O. B.	DATE
	X			Net 30	Origin	8/17/72

ITEM	QUANTITY	PART NUMBER	DRAW REV.	DESCRIPTION	PRICE
1	1	8155		Audio Flutter Meter (NAB) S/N 00051	645.00/ea
2	1	8155		Audio Flutter Meter Serial 00035 Demonstrator	N/C

NOTES:

1. Parts required on our dock as follows:

   Item 1: 9/15/72 or sooner Item 2: 8/24/72

2. Item (2) to be returned to 3-M within three working days of receipt of Item 1.

3. Confirming telecon between John McCracken and Tom Fenner on 8/17/72. 805-482-191

Del 000 1640-161 ~~CAP EQUIP-ASSET #9881~~

ITEM NO.	QUANTITY OR WEIGHT REC'D	QUANTITY OR WEIGHT PACK LIST	BALANCE DUE	DATE REC'D	REC'D BY	CARRIER	PRO. NO.	NO. PIECES	WEIGHT	REC'D COLL	REC'D PREPAID
~~2~~	~~1~~	~~34~~	~~0~~	9-13	JS	UPS			3		
1	1	24.14	0	10-26	JS	UPS			3		

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